A236-616-20m

TEXAS AGRICULTURAL EXPERIMENT STATION

BULLETIN NO. 189 JUNE, 1916

DIVISION OF CHEMISTRY

The Composition of Cotton Seed Meal and Cotton Seed

BY

G. S. FRAPS, Ph. D.,
Chemist in Charge; State Chemist

POSTOFFICE:
COLLEGE STATION, BRAZOS COUNTY, TEXAS

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*As of June 1, 1916.
**In cooperation with United States Department of Agriculture.

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THE COMPOSITION OF COTTONSEED MEAL AND COTTON SEED

BY

G. S. FRAPS, CHEMIST TO THE EXPERIMENT STATION.

This bulletin contains a discussion of the composition of cottonseed meal sold in Texas and in other States, with a description of the method of milling and with some discussion of the effect of milling on the composition of the meal. Some work on the composition of cotton seed is also given.

According to Bulletin 131, Bureau of the Census, in 1914 there were 885 cottonseed oil mills in the United States, of which 233, or 27 per cent., were in Texas. They crushed a total of 4,847,628 tons of cotton seed, of which 1,191,508, or 26.5 per cent., were crushed in Texas. The comparative amounts and values of the products are given in Table 1.

TABLE 1.—COTTONSEED STATISTICS.

	United States	Texas	Texas Per Cent
Seed crushed, tons	4,847,628	1,191,508	26.5
Oil, gallons	193,333,019	41,349,603	21.4
Meal and cake, tons	2,217,378	538,752	24.3
Hulls, tons	1,402,909	367,090	26.2
Linters, pounds	334,116,513	92,970,687	27.8
Oil, value	$ 81,024,372	$ 16,296,643	20.4
Meal and cake, value	56,093,519	13,348,620	20.4
Hulls, value	11,206,774	2,793,628	24.9
Linters, value	7,711,752	1,749,180	22.7
Total	$ 156,036,417	$ 34,188,071	

Although oil is the chief product of cotton seed crushing, yet its value is little more than 50 per cent. of the total value of the products in the United States, taken as a whole, and less than 50 per cent. in Texas. Cottonseed cake or meal has over one-third the value of the total output; so that it must be regarded as one of the main products of the industry, rather than a by-product.

DEFINITION OF TERMS.

The ordinary analysis of a feeding stuff gives its content of protein, ether extract (which is very often called fat or oil), crude fiber, nitrogen-free extract, water, and ash. The terms nitrogen and ammonia are also used frequently in connection with cottonseed meal. These terms are defined briefly in the following paragraphs:

Protein is an important constituent of the feed, containing 16 per cent. nitrogen, which is used largely to form flesh, muscle, and other similar portions of the animal body. When protein is fed in excess, it may also be used for fattening purposes, or for the production of heat.

Nitrogen is a constituent of protein, and protein is calculated by multiplying nitrogen by 6.25. The statement of the nitrogen content of a feed, or of cottonseed meal, is thus equivalent to stating the protein in different terms. By multiplying the protein by 0.16 it is converted into terms of nitrogen.

Ammonia as such is not contained in protein or in cottonseed meal, but nitrogen in protein may be expressed in terms of ammonia by multiplying nitrogen by 1.215. Ammonia may be converted into terms of nitrogen by multiplying by .882, or into terms of protein by multiplying by 5.15.

Fat, or oil, is the term usually applied to the ether extract of cottonseed meal. This substance is extracted by ether and is composed mostly of fats and oils. For factory-control purposes, the oil is extracted by means of petroleum ether. This method gives somewhat lower results than the method of extracting with ethyl ether, which must necessarily be used by Feed Control Officials.

Fats and oils are used in the animal body as a source of body heat and to furnish heat and energy. Fat contains more heat or energy per pound than nitrogen-free extract or carbohydrates, having about 2.25 times the value of the digested portions of these.

Nitrogen-free Extract is a group containing a number of substances of widely different properties. In the case of cottonseed meal, it contains pentosans, a sugar known as raffinose, and some other substances. In the case of cottonseed hulls, it is composed of less valuable and less easily digested substances. The nitrogen-free extract that has been digested is used by the body for the purpose of supplying heat and energy, and for the production of fat.

Crude Fiber is that portion of the feed which is left after it has been subjected, first to the action of boiling 1¼ per cent. sodium hydroxide, and then to the action of boiling 1¼ per cent. sulphuric acid. The pure kernel of cotton seed is low in crude fiber, while the hull is high in crude fiber. The digested crude fiber has some value to the animal for producing heat, but the work involved in digestion is so great that in many cases the animal really secures no benefit from the digestion of crude fiber. The more crude fiber a feed contains, the poorer is its quality, compared with other feeds of the same character.

Ash is the residue left when the substance is burned. It consists largely of lime, magnesia, and other non-volatile constituents, as well as some carbon held in the form of carbonate.

Water is present in all feeding stuffs. A high water content is liable to cause damage to the feed by heating or fermentation, especially in warm weather. The greater the percentage of water, the lower are the percentages of other ingredients.

Productive Value. The productive value of a feed is the quantity of fat it will produce on a fattening animal, when added to a ration already sufficient to support the animal. By fat, we do not mean gain in weight, but actual fat.

Feeding Value. The feeding value of a feeding stuff may be expressed in terms of its content of digestible protein and its productive value. The former represents its value for the production or repair

of flesh; the latter its value as a source of heat, energy, or fat. An animal requires much more productive value than it does digestible protein. (For discussion, see Bulletin 170.)

PRODUCTS FROM COTTON SEED.

Table 2 contains the quantities of the various products secured from cotton seed, as calculated from the United States Census Reports and from Bulletin 131, Bureau of the Census. The report in the tenth census (1880) is evidently only an estimate.

TABLE 2.—PRODUCTS FROM A TON OF COTTON SEED.

	Meal lbs.	Oil lbs.	Hulls lbs.	Lint. lbs.	Loss lbs.	Oil gal.
U. S. Tenth Census, 1879.....	750	250	978	22	0	.....
U. S. Twelfth Census, 1899.....	713	288	943	23	33	38.0
U. S. 1904.....	813	300	725	35	127	40.0
U. S. Thirteenth Census, 1909.....	875	301	663	46	115	40.1
U. S. 1914.....	915	299	579	69	138	39.9
Texas 1899 (U. S. Census).....	730	264	948	23	35	35.2
Texas 1904 (U. S. Census).....	788	280	780	39	113	37.3
Texas 1909 (U. S. Census).....	864	224	743	51	68	36.5
Texas 1914 (U. S. Census).....	904	261	616	78	141	34.7

The table shows an increase in the quantity of meal, and of lint secured since 1880, and a decrease in the quantity of hulls. There is no evident increase in the quantity of oil since 1899 for Texas, and since 1904, for the entire country. This is not what we should expect from the results of the chemical analysis of the cottonseed meal, as it contains less oil than formerly. The lower quantity of oil is, however, offset to some extent by the larger yield of meal.

The increase in lint is due to its more thorough removal from the seed. The increase in meal is due partly to changes in methods, partly to the manufacture of products of lower grade. The decrease in hulls is chiefly due to the fact that more of them get into the meal but also to the fact that they are more closely delinted.

COMPOSITION OF TEXAS MEAL.

The average cottonseed meal on the Texas market has decreased in feeding value since 1907, when the amended feed law went into effect. This is shown in Table 3, which contains the average composition of Texas cottonseed meal, as shown by analyses made for the Feed Control from July 1, 1907, to January 1, 1916, averaged in periods of six months. These averages include both cottonseed cake and cottonseed meal.

TABLE 3.—AVERAGE PERCENTAGE COMPOSITION OF TEXAS COTTON SEED MEAL SAMPLES, COLLECTED BY FEED INSPECTORS.

	Protein	Fat	Crude Fiber	Nitrogen Free Extract	Water	Ash	No. Samples	Digestible Protein	Productive Value
July 1, 1907–Jan. 1, 1908..	47.65	9.73	6.50	23.74	6.62	5.76	266	41.07	19.28
Jan. 1, 1908–July 1, 1908..	47.89	8.94	6.91	23.79	6.86	5.61	158	41.28	18.87
July 1, 1908–Jan. 1, 1909..	47.42	8.99	6.78	25.05	6.05	5.71	159	40.88	19.04
Jan. 1, 1909–July 1, 1909..	44.86	9.09	7.65	26.34	6.24	5.81	98	38.67	18.78
July 1, 1909–Jan. 1, 1910..	47.41	9.13	7.66	23.37	6.90	5.53	212	40.87	18.78
Jan. 1, 1910–July 1, 1910..	45.75	8.91	7.85	25.15	7.09	5.25	74	39.44	18.63
July 1, 1910–Jan. 1, 1911..	46.54	8.98	7.66	25.07	6.49	5.26	223	40.12	18.83
Jan. 1, 1911–July 1, 1911..	45.55	8.87	8.15	25.22	6.97	5.28	112	38.95	18.39
July 1, 1911–Jan. 1, 1912..	46.59	8.79	7.78	24.60	6.76	5.48	184	40.16	18.63
Jan. 1, 1912–July 1, 1912..	45.21	8.33	8.79	24.77	7.42	5.48	163	38.65	17.92
July 1, 1912–Jan. 1, 1913..	44.87	8.57	8.91	25.64	6.66	5.35	174	38.36	18.13
Jan. 1, 1913–July 1, 1913..	44.79	8.37	9.22	25.13	7.15	5.34	189	38.30	17.87
July 1, 1913–Jan. 1, 1914..	45.14	8.51	9.52	24.05	7.33	5.45	140	38.59	17.86
Jan. 1, 1914–July 1, 1914..	44.46	8.50	10.05	23.52	7.90	5.57	130	37.70	17.46
July 1, 1914–Jan. 1, 1915..	45.42	8.08	8.61	25.14	7.07	5.68	208	38.83	17.89
Jan. 1, 1915–July 1, 1915..	44.19	7.86	9.39	25.46	7.34	5.76	185	37.78	17.56
July 1, 1915–Jan. 1, 1916..	43.71	7.38	10.62	25.35	7.41	5.53	257	37.07	16.98

An examination of the table shows a decrease in protein and in fat, and an increase in nitrogen-free extract and crude fiber. The ash content is little variable and the water content shows a slight increase.

There is a general tendency for the protein and fat to be higher and the crude fiber to be lower during the first six months of the season. The lower per cent. of protein and fat found during the second six months is accompanied by a higher amount of crude fiber, but this increase in crude fiber is not always in proportion to the decrease in protein over the first six months. In 1908-9, for example, during the first six months of the season, cottonseed meal averaged 47.42 protein and 8.99 fat; while, during the second six months, the average was 44.86 protein and 9.09 fat. In the first period, the average percentage of crude fiber was 6.78; while during the second period it was 7.65. Thus a decrease of 2.56 per cent. in protein is accompanied by an increase of only 0.87 per cent. crude fiber. This indicates that the seed worked during the second period contained a smaller per cent. of protein than the seed worked during the first period. A similar difference in the seed is indicated in some of the other periods.

An increase in the crude fiber in cottonseed meal means an increase in the quantity of cottonseed hulls present. An examination of the table shows a steady increase in crude fiber. There has thus been, on an average, an increase of cottonseed hulls present in cottonseed meal sold in Texas. The average Texas feeders in 1915 received cottonseed meal that contains considerably less protein and more hulls than was received by the feeders in 1907. The guaranteed value is also less, since most of the meal is now sold as *prime*, rather than *choice*.

The decrease in quality is, of course, accompanied by a decrease in feeding value. This is also shown in the table. The digestible protein decreases from 41.07 to 37.07, and the productive value, expressed as fat, decreases from 19.28 to 16.98. The decrease in quality is due

to improved methods of manufacture, and to the retention of hulls in the meal for the purpose of manufacturing prime rather than choice meal. That is to say, in 1907-8 a large proportion of the mills were making choice meal, containing about 55 per cent. protein and fat combined; but in 1915-16, only a small number of mills were making choice meal, while most of them were endeavoring to make prime meal, containing 51 per cent. protein and fat combined. The tendency is for cottonseed meal to decrease in feeding value until it reaches the minimum permitted by the State laws, or other controlling influences.

CHANGES IN QUALITY IN OTHER STATES.

The decrease in average quality of cottonseed meal observed in Texas also may be found to occur in other States when a sufficiently long period of time is taken into consideration.

TABLE 4.—AVERAGE COMPOSITION OF SOUTH CAROLINA COTTONSEED MEAL.

Season—	No. of Samples	Ammonia Per Cent
1890–1	30	8.37
1891–2	25	8.21
1892–2	20	8.40
1893–4	22	8.64
1894–5	33	8.19
1895–6	34	8.45
1896–7	40	8.69
1897–8	39	8.39
1898–9	40	8.25
1899–1900	52	8.73
1900–1	60	8.55
1901–2	49	7.93
1902–3	69	8.08
1903–4	57	7.92
1904–5	62	7.42
1905–6	71	7.51
1906–7	99	7.32
1907–8	114	7.40
1908–9	115	7.27
1909–10	133	7.20
1910–11	177	7.26
1911–12	153	7.54
1912–13	171	7.37
1913–14	188	7.28
1914–15	90	7.21

South Carolina.—Table No. 4 shows the average composition of samples of South Carolina cottonseed meal collected under the fertilizer law, as given in Bulletin No. 181 of the South Carolina Experiment Station. The average composition from 1890-1 to 1900-1 shows no decrease, but varies irregularly from 8.19 per cent. ammonia (42.17 protein) in 1894-5 to 8.73 per cent. ammonia (44.96 protein) in 1899-1900. After 1900-1, when the average ammonia was 8.55 per cent, there was a decrease until approximately 1908-9 (7.27 per cent. ammonia, or 37.44 per cent. protein), after which year the average is again somewhat irregular. To judge by other States, the decrease will continue until the average is very near the minimum permitted by the State law, namely, 7.0 per cent. ammonia or 36 per cent. protein.

TABLE 5.—AVERAGE PERCENTAGE COMPOSITION OF LOUISIANA COTTONSEED MEALS.

Year.	Protein	Fat	Crude Fiber	Nitrogen Free Extract	Water	Ash
1906–7	42.22	8.87	8.05	25.72	8.12	7.02
1907–08	40.88	9.84	9.22	24.58	8.75	6.73
1908–9	41.96	8.96	8.87	25.56	8.14	6.51
1909–10	42.12	8.30	9.47	26.19	7.26	6.66
1910–11	40.74	8.16	9.29	27.43	7.71	6.67
1912–13	39.26	8.06	11.16	27.68	7.51	6.43
1913–14	39.07	8.25	12.04	26.54	7.82	6.28

Louisiana.—Table No. 5 shows the average composition of Louisiana cottonseed meal, compiled from Feed Control bulletins of the Experiment Station, or of the Department of Agriculture. The average protein content of Louisiana meal decreases from 42.32 per cent. in 1906-7 to 39.07 per cent. in 1913-14. The crude fiber increases from 8.05 in 1906-7 to 12.04 in 1913-14. During this period there has been an average increase of about 4 per cent. crude fiber or about 9 per cent. hulls. It is to be expected that the decrease in quality will continue until some effective check is interposed.

Massachusetts.—Table No. 6 shows the average composition of cottonseed meal sold in Massachusetts as given in Bulletin No. 158 of the Massachusetts Experiment Station. There is a very large decrease in protein, from 46.02 in 1907 to 40.2 per cent. in 1914, and an increase in crude fiber from 5.08 per cent. in the first period to 9.04 per cent. in the last period. This is an increase of 3.06 per cent. crude fiber or about 8 per cent. hulls. Unless some other check is interposed, the decrease in quality may continue until the Interstate minimum of 36 per cent. protein is nearly reached, when the crude fiber would average about 13.4 per cent. The demand for *prime* or *choice* meal may also interpose a check.

TABLE 6.—COMPOSITION OF COTTONSEED MEAL SOLD IN MASSACHUSETTS.

Year	No. of Samples	Protein Per Cent	Fat Per Cent	Fiber Per Cent
1897–1902	93	46.2	11.2	5.8
1902–1906	190	45.4	9.6	6.4
1906–1911	85	42.0	9.2	7.3
1911	30	41.0	8.2	7.7
1912	64	41.0	7.7	8.4
1913	87	40.2	7.7	9.2
1914	50	40.2	7.6	9.4

Other States.—Table No. 7 shows the average composition of various cottonseed meals sold in other States. We have not attempted to collect averages for a sufficiently long period to show the changes discussed above. The average composition of cottonseed meal quoted from the "Cotton Plant" represents analyses made before 1900. They show a high protein and fat content and a very low crude fiber content as compared with the recent analyses given in the table. The

high fat content (14.23 per cent.), of course, means a great loss of valuable oil due to incomplete extraction, and the decreased oil content shown by recent analyses shows decided improvements in the methods of extraction. The increase in crude fiber shows the presence of an increased quantity of hulls.

TABLE 7.—COMPOSITION OF VARIOUS COTTONSEED MEALS.

	No. Samples	Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	Fat	Water	Ash
The Cotton Plant (to 1890)	.....	44.09	.....	5.16	20.85	14.23	8.62	7.05
The Cotton Plant all Meal 400	.....	43.26	.....	5.44	22.31	13.45	8.52	7.02
New York, 1911 for 1910	26	40.25	8.03	9.11				
New York, 1912 for 1911	36	41.16	8.29	6.99				
New York, 1913 for 1912	34	40.70	8.26	8.31				
New York, 1914 for 1913	17	39.81	7.55	9.89				
New York, 1915 for 1914	23	40.65	7.71	8.97				
New Jersey, 1909–10	.....	39.12	8.08	8.61				
New Jersey, 1910–11	.....	40.05	8.49	7.83				
New Jersey, 1911–12	.....	39.70	7.98	8.25				
New Jersey, 1912–13	.....	40.30	7.98	8.86				
New Jersey, 1913–14	14	40.40	7.86	8.55				
Pennsylvania, 1906	9	41.21	9.09	.....				
Pennsylvania, 1907	11	39.16	9.55	10.16				
Pennsylvania, 1908	24	41.75	8.79	8.39				
Pennsylvania, 1909	34	41.41	8.69	8.15				
Pennsylvania, 1910	47	40.11	8.18	8.73				
Pennsylvania, 1911	53	41.19	8.34	8.65				
Pennsylvania, 1912	87	40.87	8.44	9.53				
Pennsylvania, 1914	83	40.88	7.97	10.11				
Kentucky, 1914	.....	40.90	7.79	9.95				
North Carolina, 1906–7	.....	38.31	.....	.....				
North Carolina, 1908–9	.....	39.95	.....	.....				
North Carolina, 1912–13	144	38.50	.....	.....				
Georgia, 1913–14 (fertilizer)	144	41.87	.....	.....	.....			
Georgia Feed, 1911–12	17	38.11	7.64	10.46	30.22			
Georgia Feed, 1912–13	27	38.43	8.62	9.92	28.23			
Georgia Feed, Nov., 1913–1915	32	38.34	7.65	9.36	31.51			

The average New York analyses, average from the Experiment Station bulletins, show an almost stable condition with regard to protein and crude fiber. These are quite similar to the analyses averaged from the New Jersey Experiment Station bulletins. The analyses made in Pennsylvania from bulletins of the Department of Agriculture, with the exception of 1907, show an increase in crude fiber. In the case of North Carolina, with the exception of 1906-7, the average composition reached several years ago the minimum of 7.5 per cent. ammonia permitted by the fertilizer law. The average Georgia analyses made under the fertilizer law are somewhat above the minimum of 7.5 per cent. ammonia permitted by the fertilizer law, but the averages made under the foregoing law are below the minimum of 7.5 per cent. ammonia or 38.63 per cent. protein.

Table No. 8 shows the average composition of cottonseed meal made in some Georgia mills during August and September according to a statement of the Picard-Law Company, Atlanta, Georgia, printed in the Oil Miller, October, 1915. The analyses do not represent the larger mills, which have their own chemists. The number of mills that were represented in August and September, 1915, was 54; while

the number represented in previous years was not given. A decrease in the quality of cottonseed meal as shown by the ammonia content is clearly shown. Meal sold in Georgia may not contain less than 7.5 per cent. ammonia. These analyses show that considerable quantities of a product below the Georgia requirements have been made in Georgia during August and September for a number of years. This meal may have been exported to foreign countries or to States that have a lower protein requirement than Georgia, and not sold as cottonseed meal in Georgia contrary to Georgia law.

TABLE 8.—COMPOSITION OF GEORGIA COTTONSEED MEAL IN AUG.-SEPT.

Aug.-Sept.	Moisture Per Cent	Oil Per Cent	Ammonia
1911	9.18	8.36	7.25
1912	9.13	7.96	7.12
1913	9.46	7.51	7.39
1914	9.17	7.38	7.46
1915	9.40	6.61	7.05

CAUSES OF DECREASE IN QUALITY.

The decrease in quality of cottonseed meal is due to two causes.

First. It is due to improvements in the process of oil milling, leading to a better separation of meats from the hulls and a better extraction of oil from the cake.

Second. It is due to the control of the hull content of the meal for the purpose of making meal of the desired protein (nitrogen or ammonia) content, or protein and fat content.

These two topics will be discussed in subsequent pages.

DESCRIPTION OF THE PROCESSES OF OIL MILLING.

In order to discuss properly the improvements in the processes of oil milling, it is necessary to have a description of the process of oil milling.

One Description.—The following is one outline of the process of crushing cotton seed:

The seeds are unloaded from the cars and placed in piles upon the floor of the warehouse. In some cases, they are distributed in several places, and thus mixed with other seeds; in other cases, the different kinds are piled separately. The seeds are taken first to machines, which remove dust, dirt, cotton bolls, trash, loose lint, etc., the valuable portions being saved. The amount of dirt and trash is, in some cases, considerable. Dirt and trash removed from the cotton during the process of ginning are sometimes mixed with the seed by the ginner. This is now prohibited in Texas by the warehouse law.

The seeds are then *reginned,* once or more, for the purpose of removing some of the short lint adhering to them. Under ordinary conditions this lint is worth ½ to 1 cent per pound, but during war conditions, it has been worth as much as 7 cents per pound, as it is used in the manufacture of gun cotton. The seed may be reginned

moderately, or closely, or several times. The lint secured in the close reginning is so short that it is ordinarily of low value, and under normal conditions its removal is not often profitable.

The seed next go to the *hullers*. They consist of a series of knives revolving on a disc or cylinder against a fixed knife. The hullers cut the seed so that the kernels may drop out. Two hullers are usually used, but sometimes only one. When two hullers are used, the first one cuts most of the seed. The second one cuts the remainder and grinds the hulls so that the desired amount of hull-bran goes in with the kernels. The adjustment of the knives is varied to suit the size of the seed, the cut desired in the first huller, and the amount of grinding desired in the second. With three hullers, the introduction of hull-bran is still more easily regulated. With only one huller, it is difficult to cut all the seed properly; either there is a loss of oil, by absorption by the lint or hulls, or loss of meats, due to uncut seed.

The first huller should cut the hull only, so that the entire kernel drops out, but of course a certain proportion of the kernels are cut. If the kernels are cut too much or are mashed by dull knives or wrong adjustment during the hulling, oil is absorbed by the hulls or the lint on the hulls, and fine particles of the kernels stick to the hulls or are mashed into them or the lint. The result is a loss of oil due to *absorption*. Close delinting is said to reduce loss of oil by absorption. The mixture of the hulls, kernels, and uncut seed from the first huller go to the *first shaker*, which carries perforated metal screens, which are usually flat and vibrate by shaking. In going over the screens, the hulls felt together, and the kernels drop through the perforations and are conveyed to the rolls. The sizes of the perforations are adjusted to the kind of seed and the grade of meal desired. The Atlanta Utility Works, on page 7 of the Oil Miller for February, 1915, and elsewhere, advertise shakers with "Removable sash to regulate the ammonia."

When the seed are closely delinted, there is difficulty in separating, which is sometimes overcome by the use of unperforated metal before the screens in the first shaker, which permits the hulls to felt together before they reach the perforations.

The hulls and uncut seeds from the first shakers go to the *first beaters*. These are a cylindrical screen containing revolving paddles which beat the material, knock out the kernels and permit them to fall through the perforations of the screen. The kernels usually fall upon a second flat screen, which makes a further separation of kernels from hulls. The kernels go into the conveyor to the rolls. The tailings from the first beater go to the *second huller*. The knives of this huller are set sufficiently close to cut all the seed that pass the first huller, and also to grind the hulls, so as to put a sufficient quantity of hulls in with the kernels to make the desired composition.

The Carver Company make the following statement in regard to second hulling:

"In the process of Cotton Seed Oil Milling where it is desired to do double hulling, or regrind the hulls to obtain hull-bran, the Disc Huller is the proper machine for this work. At this point in the progress of the product through the mill there should be very little

of the cottonseed meats or meals in the hull; in fact, if the previous operations have been performed efficiently, the amount of meats should not be above 1 or 2 per cent. This, therefore, allows for the efficient use of the disc huller, its abrasive action being just what is desired to grind the hull to a fine state, thus producing a product that allows of a separation giving hull-bran and hull; but, due to the low percentage of meats, the absorption loss becomes negligible."

The product of the second huller falls upon the *second shaker*, consisting of vibrating screens like those of the first shaker, but with different perforations. The kernels and hull-bran go into a conveyor to the rolls. The hulls go to a *second beater* similar to the first beater. The hulls from this machine go to the hull house and the product, consisting of hull-bran, with very little kernels, goes to the rolls.

The mixture of kernels and hull-bran from the first and second shaker and the first and second beater go to the rolls, where they are crushed into thin flakes, for the purpose of rupturing the oil cells.

They then go to the *cookers*, where they are cooked by steam under a pressure varying from 100 pounds to 30 pounds, for about forty minutes. In case of a very dry seed, some water may be added before the kernels are cooked. In case of damp seed, there is a loss of moisture during the cooking.

The cooked product is then formed into cakes, covered with cloth made of camel's hair and placed in hydraulic presses. The oil is then expelled by means of hydraulic pressure in presses usually holding 16 press boxes, and the residue consists of a hard slab of cottonseed cake about $\frac{1}{2}$ inch thick, 32 inches long, and 14 inches wide, weighing about 13 pounds. When meal is desired, the cake is first broken up in a *cake breaker*, and then ground to a fine meal.

The above is known as the *hydraulic process*, which is the usual process. In the *expeller process* (sometimes called cold-pressed process), the kernels and hull-bran are separated as described above; and then, without previous cooking, the oil is expelled by passing the mixture through the expeller, where it is subjected to intense pressure by means of rolls. The rolls and the product become hot during the expression. This product is in the form of flakes, but is similar in chemical composition to hydraulic cottonseed cake or meal. It should not be confused with cold pressed cotton seed (so-called), which is made from the entire seed from which the hulls have not been removed, and therefore contains a large percentage of hulls.

Another Description. The following is a description of another modification of the process, as given in Catalogue No. 75 of the Bauer Bros. Company:

"The illustration on pages 22 and 23 shows a complete hulling and separating plant in connection with which the 'scientific' hull retaining process is used. It will require but little explanation to enable the practical Oil Mill man to understand the process as shown. The conveyor bringing the seed from the linters is continued over the top of all machines, dropping and passing the seed through the huller, which is the first machine in the installation, and it must be so adjested that the hulling plates will cut all the seed as in an ordinary

single hulling plant. This adjustment is quickly accomplished by means of the temper screw at the end of the shaft. The 'scientific' patented deflecting valve is located above the top screen, which must be so adjusted that 50 per cent of the product from the huller is immediately passed to the bottom screen, the remaining portion being evenly distributed over the top screen.

"The meats from both screens are delivered to a 9-inch conveyor located on the floor, and passing under the discharge of all the separating machines in the system. The tailings from the double shaker are dropped into another 9-inch conveyor located on the floor and running parallel with the meats conveyor referred to above, and by this conveyor delivered into the boot of the elevator which returns them to the conveyor above the separator. The meats recovered by this machine are also delivered into the meats conveyor, joining the meats from the first double shaker. The tailings from this beater are delivered into the outside hull conveyor, and carried to the boot of the second elevator and again returned to the conveyor above the machines, and by it delivered to the second disc machine, which is equipped for retreating the hulls.

"The purpose of this retreating process is threefold:

"1. To produce just the right amount of good, clean hull-bran to control the ammonia content of the meal.

"2. To remove from the hulls all meats that may be adhering to them by reason of imperfect hulling.

"3. To recover any whole seed that may, by accident, have escaped the huller.

"The steel frame shaker beneath removes a large percentage of the hull-bran, which product is discharged into the meats conveyor, joining the meats recovered by the preceding machines. The tailings are dropped into the outside conveyor and delivered into the boot of the third elevator, which again returns them to the conveyor above the machines which delivers them to the finishing beater, where all the remaining hull-bran and fine floury meats are recovered and dropped into the meats conveyor on the floor, then passing on to the rolls, the finished hulls being conveyed to the hull house, or to the extinguisher."

A Superintendent's Outline. The following outline of cotton seed manufacture is taken from a paper read by F. E. Voorhees in the Proceedings of the Oil Mill Superintendents' Association, June, 1913:

"1. *Character of Seed and Its Influence Upon the Yield and Quality of the Oil.*—We all know the cotton plant requires from five and a half to six and a half months for maturity. The various conditions prevent a uniform quality of seed. Thus we have from the picking, uripe, half ripe, and ripe seed. The three kinds make it a study to store seed for oil. Quality of seed is a most important consideration in an oil mill, for the quality of the raw material determines not only the quality of oil expressed, but the percentage yield of oil as well. Inferior seed usually produces inferior crude oil, and it takes skill to work inferior with good seed and it involves great danger to the quality. Seed ought to be graded and milled separately. Different locations furnish more or less moisture to the seed, but seed obtained from

the first picking contain more moisture than seed picked later in the season.

"2. *Classification.*—Seed should be classified according to its degree of maturity. The riper seed is the superior; as the unripe seed is inferior, so is wet, musty, and rotten seed; it is composed of unstable organic compounds, and when in bulk it has a great influence on heating. To have prime seed, it should be sacked.

"3. *Storage.*—Seed that has undergone any amount of heating will not produce prime oil. For this reason, in storage, seed sacks ought to be used. Many places do not sack the seed on account of storage capacity. In sacks it requires from 90 to 95 cubic feet per ton and in bulk or loose only 85 cubic feet, and when packed, only 65 cubic feet, but no matter, seed must be kept cool and dry.

"4. *Handling Seed.*—The drier the seed, the easier it is to handle them and less apt to clog the spouts and passageways.

"5. *Cleaning.*—This is the foundation for the proper handling of the material for the press room. The seed is received contaminated with various amounts of foreign matter, such as bolls, flocks of lint, pebbles, sand, twigs, leaves, nails, bolts, metal, etc., which must be removed: all oil mills must be equipped with ample cleaning machinery. In the preliminary mechanical treatment of the raw seed, the loss in weight arises from two sources, viz.: separation of mixed foreign matter and separation of material. Moisture of the seed is about 6 per cent. of the weight of the original seed, but conditions will increase the loss.

"6. *Regrinding or Delinting.*—We must have the linters well set with sharp saws, for a good delinting helps the hulling and the separation.

"*Hulling.*—Hulling is a very difficult process, the dryer the seed is the better the hulling is done, for when thoroughly dry and free from all excess of lint it is not so hard to accomplish. The hull is easily broken and the meat is loose and drops out of the cracked hull; but when the seed is not well matured, damp and soft, the hull will not break but mashes. It is hardly possible to get the meats from the hulls. Seed must be cut but not mashed. It is why in the new oil mill practice we use with such effectual results, I mean the use of the disc huller, which the cutting edges of the plates have the proper method of cutting, instead of mashing the seed, and eliminate a great deal of that oil absorption, and after that process is gone through, some well-built shaker receives the mess of cut seed which is treated in its travel and causes the meats to fall through perforations of a mesh 3-16-inch for 8 feet and ¼-inch the last 2 feet for a first treatment.

"7. *Separating Meats and Hulls.*—When seed is hulled, enough lint must remain on it; the lint adhering to the hulls that remain with the meats causes them to felt together in wads. They are tossed upon the shaker, which prevents them from falling through with meats when sifted out. Many mills are installed with a regrinder: that is, a second disc huller is installed and receives the hulls and unseparated seed from the first shaker treatment. This process is acknowledged to be of great value, for it positively reduces the oil in the hulls

to less than 1 per cent., and clears the hulls of practically all meats; it produces a maximum cake and meal free from objectionable lint, and it furnishes the desired percentage of hull-bran, and regulates the ammonia content of the meal. It enables you to manufacture a cake to any class you desire it—choice, prime, or a very low grade of protein meal.

"8. *Crushing.*—The purpose of crushing is to rupture the oil cells and to so break down the structure of the kernel that all parts may be equally exposed to heat in the cooking process, whereby the mass is thoroughly and uniformly softened to permit the freest egress of the oil in the press. Crushing rolls must be ground true and even; it is important to operate them properly and uniformly and always keep an uninterrupted feed on the rolls; a hasty, irregular, or intermittent feeding affects materially the yield of oil in the press. A common practice in many mills is that the sweepings of uncrushed kernels are put in the rolls. Under no circumstances should it be done. Let it be returned to the separator shaker and not allowed to go in with the crushed meats when the meats are uniformly soft and crushed. The cooking is more efficiently done and the oil separation in the press easily done and in large quantities. Improperly crushed meats mean inefficient cooking. Inefficient cooking means a low yield of oil of inferior quality and wasteful use of press cloths. Inferior oil means large waste on refining and reduces yields of refined oil. Too much stress cannot be laid upon the care with which each step in the manipulation of the seed is performed.

"9. *Cooking Meats.*—If the efficient performance of one step in the preparation of cottonseed oil is more important than another, or if there is one in which the character of the seed has a greater determining influence upon the yield and quality of the product, it is cooking. Cooking is modifying the consistency of the meats through heat, that the maximum yield of oil may be expressed. The coagulation of the albumin expels the excess of natural moisture by absorption and reduces the meats to the consistency desired for the best results."

EFFICIENCY OF THE MACHINERY.

Walter Leonard, in the Proceedings of the Oil Mill Superintendents' Association, June, 1913, states:

"In our modern press rooms, with improved and scientific methods, we are able to make from 800 pounds to 1000 pounds of cake of any desirable chemical analysis. It is possible to regulate the ammonia content, protein and fat, and other constituents to a point that will deviate but a small percentage from an agreed-upon standard."

J. C. Newberry, in the Proceedings of the Oil Mill Superintendents' Association, 1913, says:

"By having your perforations graded closely, you can regulate your ammonia, protein, and fat very closely. As I have stated before, I have my equipment so arranged that if the office sees fit to sell anything from 45 to 55 per cent. meal, I can make the necessary changes within a short time."

By "45 to 55 per cent. meal," he means that which contains 45 to 55 per cent. protein and fat combined.

COMPOSITION OF INTERMEDIATE PRODUCTS.

Table No. 9 shows the composition of some intermediate products obtained during the process of oil milling. No attempt has been made to collect a large number of these products. The products of the first huller and shaker consist almost entirely of cottonseed kernels; while products of the second huller, which come from the second shaker and the second beater, contain a large quantity of hulls or hull-bran.

TABLE 9.—COMPOSITION OF INTERMEDIATE PRODUCTS.

Laboratory Number.		Protein	Fat	Crude Fiber	Nitrogen Free Extract	Water	Ash
11124	Product of first shaker	35.63	29.62	5.50	17.98	6.80	4.47
11129	Product of first shaker	36.75	30.94	4.67	17.03	5.77	4.84
11991	Product of Second shaker	19.19	14.48	23.74	31.43	7.68	3.48
11125	Product of second shaker	17.72	9.03	25.23	33.77	7.34	6.91
11130	Product of second shaker	31.19	24.91	10.91	21.96	6.55	4.48
11126	Product of second beater	10.38	5.99	33.27	37.61	9.63	3.12
11131	Product of second beater	16.53	11.63	26.78	33.51	8.26	3.29

IMPROVEMENTS IN PROCESSES OF MILLING.

Improvements in recent years in processes of manufacture, leading to a better separation of meats from the hulls and better extraction of oil from the cake, have caused a decrease in the oil content of cottonseed meal, and perhaps, to a limited extent, an increase in its hull content, with a consequent increase in crude fiber.

The improvements are due largely, if not entirely, to control exercised by means of chemical analysis over the final products, and, when necessary, over the operation of the various machines. The improvements relate to *absorption* of oil, *separation* of kernels, and *extraction* of oil.

Absorption.—Considerable quantities of oil were formerly lost through absorption by the hulls. This was largely due to the mashing of the seed during the hulling, through the use of hullers with knives not properly set or not sharp enough. It was also due to the use of only one huller. When only one huller is used, it must be set close enough to cut practically all the seed, and as the seed vary somewhat in size, the huller must be set somewhat close. When the huller is thus set, all the kernels are cut, and oil is absorbed from the cut surfaces, and some of the material is rubbed into the lint or hulls. Thus with seed not uniform in size, cut on a single huller, there is likely to be either losses by absorption, or losses due to incomplete separation of the hulls from the seed.

At present, in mills where the amount of absorption is ascertained often by chemical analysis of the hulls, it has been reduced to practically zero. This is due not only to the use of the second huller but

to experience in the details of adjusting the hullers, the screens, and the beaters to suit the character of the seed being worked. Sometimes an estimation is made of oil in the hulls from each of the various machines to ascertain at what stage oil is lost by absorption.

The principle involved in preventing absorption is to cut the minimum amount of kernels and to separate the bulk of the kernels from the hulls as quickly as possible. This is done in the first huller and through the first shaker. In many cases, a large proportion of the kernels are not cut at all, the hulls being cut in such a way as to allow the whole kernel to fall out. When lint is closely removed, it is often advisable to have the mixture of kernels and hulls fall first on unperforated metal, so that the hulls may felt together before reaching the perforations.

Separation.—When the separation is incomplete, uncut seeds and parts of kernels go into the hulls. Hulls now made contain practically no whole seed. This is partly due to the use of two hullers instead of one, and partly to attention to details of setting the huller knives and other machine adjustments.

On account of better separation, cottonseed hulls, as now made, contain much less protein and fat, and more crude fiber, and nitrogen-free extract, than those formerly made, and analyses made several years ago no longer represent the cottonseed hulls on the market. On account of the closer adjustment of the second huller required to cut all the seed, and make a complete separation, somewhat more hulls must necessarily go in with the meats than was formerly the case. The recent reduction of the quantity of lint of the hulls reduces the percentage of crude fiber in the hulls.

Extraction.—Cottonseed meal as made before 1890 contained, on an average, 13.45 per cent. oil. (Table No. 7.) Cottonseed meal made in Texas from July 1 to January 1, 1907-8 (Table No. 3) contained 9.73 per cent. fat, or oil. This is a decrease of 3.72 per cent., or 74.4 pounds per ton of meal, or nearly 10 gallons of oil per ton of meal, or about 4.4 gallons per ton of seed. If the oil is worth about 6 cents a pound, and the meal 1½ cents, the gain in oil and the loss in meal at 4½ cents per pound would represent about $3.35 per ton of meal, or about $1.45 per ton of seed.

The average oil content of the Texas meal from July 1 to January 1, 1907-8, was 9.73 per cent., and from January 1, 1915, to July 1, 1915, it was 7.86 per cent. This is a decrease of 1.87 per cent. fat, and is an increase of 37.4 pounds per ton of meal, or about 5 gallons per ton of meal, or 2.2 gallons per ton of seed, or $1.63 per ton of meal, or $0.81 per ton of seed at the prices given above.

It is said that some mills controlled by frequent chemical analysis of the meal have averaged 5.7 per cent. fat during the past year. If one allows 0.3 per cent. for the difference in extraction with petroleum ether used in mill control work, the amount of oil will be 6 per cent. according to Feed Control methods, or a further possible average decrease of 1.86 per cent. This would be a gain of 37.2 pounds of oil per ton of meal, which is about the same as the average decrease which occurred from 1907-8 to 1915; and, at the prices given,

would amount to $1.63 per ton of meal or $0.81 per ton of seed. In a crush of 1,191,508 tons of seed in Texas, this would be over $960,000.00.

The value of the increase due to the reduction of oil would, of course, vary with the relative prices secured from meal and oil. In some cases, these are materially below the figures used.

The possibility of such a result is shown in Table No. 10, which contains daily analyses which a mill in Texas had made for control purposes. The average fat content during the period given is 6.10. It requires, however, frequent analyses to secure such results.

TABLE 10.—PERCENTAGE COMPOSITION OF CAKE OF AN OIL MILL ON DIFFERENT DAYS.

Date	Protein	Oil	Moisture
October 20, 1915	44.20	8.29	11.00
October 21, 1915	42.87	5.24	8.75
October 22, 1915	43.38	5.63	8.04
October 25, 1915	43.90	5.62	8.76
October 28, 1915	43.07	6.08	9.00
October 29, 1915	45.80	5.90	8.15
November 1, 1915	44.56	6.38	8.65
November 2, 1915	46.31	6.55	9.90
November 3, 1915	43.33	6.11	8.58
November 20, 1915	42.92	6.78	8.50
November 27, 1915	43.84	6.06	8.70
December 1, 1915	45.65	6.47	8.42
December 6, 1915	42.20	5.77	10.75
December 11, 1915	42.92	5.50	9.30
December 14, 1915	43.23	5.98	9.25
December 17, 1915	43.90	5.88	9.30
December 23, 1915	42.97	5.95	8.60
December 31, 1915	45.59	5.64	9.00
Average (18)	43.70	6.10	9.03

The improvement in the extraction of oil shown above may be ascribed to better attention to all the details of manufacture, including the rolling, cooking, and pressing, as well as other processes, due largely to the check or pressure produced by the chemical analysis of the products, upon the carefulness and attention of the superintendents.

This is emphasized by H. G. Hawk in an article read before the Oil Mill Superintendents' Association, June, 1913, as follows:

"So lastly we just want to notice the fact that for scientific press room work such as getting a high grade of oil, 7½ per cent. ammonia cake or any standard we desire, and a cake that will only contain 2½ per cent. or 3 per cent. of oil will require the well-trained eye, the touch and all that go to make up scientific press room work; will require about all the energy, close observation, and practice most of us care to put out."

It is claimed by some oil mill men that the presence of a certain amount of hulls with the meal insures better drainage and a more complete extraction of the oil. This is discussed in a later section.

ANALYTICAL CONTROL OF OIL MILLING.

Analytical control of oil milling is exercised through analysis of the seed, the cake or meal, the hulls, and, when necessary, the intermediate products of the manufacture.

Seed.—Analysis of the seed is made for the purpose of ascertaining the possible yields of oil, cake, and hulls of the desired composition so as to adjust the machinery as may be necessary. It is also made for the purpose of ascertaining the localities which produce seed of a high oil content. Lint may be estimated on the seed before and after reginning to test the efficiency of the delinting process.

Cake or Meal.—Cake or meal is analyzed for protein, fat, and moisture, to see that it comes up to the necessary guarantee, to check the processes of manufacture, and to see that as much oil has been secured as is possible. If the cake or meal is below guarantee, it may be brought up to the guarantee by mixing it with a product of higher analysis. If the oil is running high, it shows that the superintendent must exercise more care in the press room work.

Hulls.—Hulls are analyzed for uncut seed, for kernel particles, and for oil. The object is to see if any seed or kernel particles have escaped the machinery, or if any absorption of oil has taken place, and to make the necessary changes in such event.

Intermediate Products.—When losses by absorption of oil, or by escape of meats or uncut seed cannot be checked, analysis may be made of the tailings from the various machines to test their efficiency and to ascertain where the trouble occurs. By proper means such loss may be then checked.

Oil.—Oil is sold on analysis, and the analysis is made for trade purposes rather than for control purposes.

Weights of Products.—A well controlled mill will have arrangements for weighing the oil and cake secured from each period's run of seed. A decrease in oil output may then be quickly ascertained, and checked, if not due to the low oil content of the seed.

RELATION OF CRUDE FIBER TO EXTRACTION OF OIL.

It is claimed by some oil mill men that the presence of hulls or hull-bran makes the cottonseed cake more porous and permits a better extraction of oil in the hydraulic presses. This claim was advanced in justification of the addition of hulls to cottonseed meal in excess of a limited amount.

Granting that a certain amount of hull-bran is needed for drainage, the pertinent question is whether the quantity needed exceeds the equivalent of 9 per cent. crude fiber, and, if so, to what extent?

Beyond the assertions of the oil mill men referred to above, little evidence has been offered in regard to this matter.

Mr. Law, President of The Picard-Law Company, in the Oil Miller, October, 1915, has the following to say:

"Press room work, especially in Georgia, is excellent. Twelve of the fifty-four mills rendering meal samples show an average oil left in the cake which is less than 80 per cent. of the ammonia percentage, and the total average is 92 per cent. This strengthens our contention that the best press room work is obtained in the Southeast under modern milling methods when the meal shows between 7 and 7.25 per cent. ammonia. Here is a comparison of September work for the past five years." (See Table No. 8, page 12.)

An examination of the table referred to shows that the average oil content of the meal decreases regularly from 8.36 to 6.61; whereas, the ammonia content of the meal varies irregularly from 7.46 to 7.05. The highest ammonia content is associated with next to the lowest oil content, and the highest oil content with the third from the lowest ammonia content. Thus the decrease in oil from 8.36 to 6.61 per cent. is not associated regularly with decreased ammonia, but is due to other causes (better control).

The following is contained in an editorial in The Oil Miller, October, 1915:

"Hulls, or fiber, so-called, in the meal or raw meats enter materially into the determination of economical manufacturing of cottonseed oil. There is a point somewhere around 7 per cent. ammonia meal at which the cost of producing oil reaches the minimum. Just at what point has not been definitely determined, but it requires a given amount of hull or hull-bran in the meats to insure the highest degree of drainage in the mass being pressed." The 7 per cent. ammonia refers to meal made in Georgia, which is made from seed containing less protein than the seed grown in Texas.

B. W. Couch, President of the Texas Cottonseed Crushers' Association, stated, in reply to a question, at a public hearing on cottonseed products November 2, 1915, that equally as good yields of oil could be secured when making Texas choice meal as when making Texas prime meal. He went on to explain that while the percentage of oil in the choice meal might be a little higher, the yield of cake would be less; so that the total yield in gallons of oil would be the same. He also stated that an excess of hulls caused a loss of oil.

A number of other oil millers have returned a similar reply to this question, and have stated that they secure equally as good yields of oil when making choice meal as when making prime Texas meal.

The fact that the cake may contain a smaller percentage of oil, but the yield of oil may be the same, or less, due to a larger total production of cake, is explained as follows by Thomas C. Law, of Atlanta, Georgia, in an article in The Oil Miller, September, 1913:

"Our standard on meal reports is figured so as to put all mills on an equal basis. The only way of doing that is to figure as near as possible the pounds of meal made per ton of seed from the ammonia which the meal contains. Of course, the higher the ammonia the smaller the yield of meal, and vice versa. We adopted for a standard 900 pounds of meal, showing 7½ per cent. ammonia per ton of seed. We adopted for a standard press room efficiency 6 per cent. of oil in meal when ammonia is 7½ per cent.; in other words, the oil per cent. should be 80 per cent. of the ammonia per cent.

"Now take, for example, two reports on meal; one shows 6.85 per cent. ammonia and 6.26 per cent. oil, the other 8.22 per cent. ammonia and 7.42 per cent. oil. The last is the best press room work. Its standard is 0.90, while the first is 0.91. Here is the reason: First our standard which shows that 900 pounds of 7½ per cent. meal containing 6 per cent. oil, means that 54 pounds of oil is left in cake per ton of seed. If you get 900 pounds of 7½ per cent. ammonia meal, you should get 985 pounds of 6.85 per cent. ammonia meal.

This meal contains 6.26 per cent. oil, which means that there are 61.66 pounds of meal left in cake per ton of seed. By the same method meal running 8.22 per cent. ammonia will produce 821 pounds. This meal contains 7.42 per cent. oil, which means that 60.91 pounds of oil is left in cake per ton of seed, more in the latter case than the former."

The meal referred to above is Eastern meal, and of lower quality than that made in Texas. The method is not strictly correct, as it assumes that all seed have the same composition.

Landon C. Moore, a commercial chemist of Dallas, Texas, stated at the hearing held at College Station on November 2, 1915, by the Feed Control Service that while one mill made cake containing 43 per cent. protein and 11 per cent. crude fiber, another mill, in another section, made, from poorer seed, cake containing 43 per cent. protein and 4 per cent. crude fiber. He was asked particularly if the separation and extraction were good, and replied that they were good in both cases. According to this statement, a difference of 7 per cent. in the crude fiber made little or no difference in the extraction of the oil. This illustration also shows how well a mill can remove hulls from the cake if it is necessary to do so.

Table No. 11 shows the comparative average composition of Texas and Louisiana meals.

TABLE 11.—COMPARATIVE FAT AND FIBER CONTENT OF TEXAS AND LOUISIANA MEALS.

	Fat		Louisiana corrected for excess hulls	Crude Fiber	
	Texas	Louisiana		Texas	Louisiana
1907–8	9.40	9.84	10.40	6.70	9.22
1908–9	9.03	8.96	9.32	7.10	8.87
1909–10	9.08	8.30	8.57	7.76	9.47
1910–11	8.93	8.10	8.35	7.90	9.29
1912–13	8.47	8.06	8.44	9.07	11.16
1913–14	8.50	8.25	8.65	9.77	12.04
1914–15	8.06	.....	.....	9.00	.....

The Texas meals averaged a higher percentage of fat and a lower percentage of crude fiber, except in 1907-8. In 1914-15, however, the Texas mills made meal with 9.0 per cent. crude fiber and 8.06 per cent. fat, doing as well as the Louisiana mills in 1912-13 or 1913-14 with a higher average of crude fiber.

The Louisiana mills also made a larger quantity of cake due to the larger amount of hulls present, the additional quantity of cake containing an additional quantity of fat and reducing the yield of oil.

This correction is made in the following way: Let us assume that one pound crude fiber equals 2¼ pounds of hulls. In 1907-8, Louisiana meal contained 2.52 per cent. more crude fiber than Texas meal, which is equal to 5.6 per cent. of more hulls. These hulls, however, contain the same quantity of fat as the meal, namely, 9.84 per cent., which is equal to 0.56 per cent. This correction should be added to the fat content of the Louisiana meal. The other corrections are made by the same method.

When this correction is made, it may be said that the extraction of oil was better in Texas than in Louisiana, in three of the six years, and nearly the same in 1912-13. In 1913-14, the Texas meal, with a much lower crude fiber content, averages a better extraction.

The evidence shows that the increased fiber content of Louisiana meals over Texas meals is not accompanied by a better extraction of oil.

An examination of Table No. 3, containing the average composition of Texas meals, shows a decrease in fat content for the season of 1914-15, and this decrease is accompanied by a lower average crude fiber content than during the previous seasons. In other words, the average decrease of fat in 1913-14 is not accompanied by an average increase in crude fiber.

TABLE 12.—COMPOSITION OF TEXAS COTTONSEED MEAL ARRANGED IN GROUPS ACCORDING TO FIBER CONTENTS 1907-1912.

	Protein	Fat	Crude Fiber	Nitrogen Free Extract	Water	Ash	Ratio Protein to Fat
To 6% average (432)	49.02	9.87	5.14	23.62	6.33	5.69	0.201
6–7% average (350)	48.28	9.34	6.48	24.15	7.01	5.63	0.193
7–8% average (315)	46.88	8.74	7.46	24.50	7.65	5.55	0.186
9–10% average (173)	44.81	8.24	9.57	25.32	6.85	5.39	0.184
10–11% average (122)	43.86	8.15	10.30	25.66	7.00	5.42	0.186
11–12% average (71)	41.66	8.02	11.27	26.46	7.01	5.29	0.192
Over 12% average (42)	39.19	7.45	13.48	27.37	7.27	5.06	0.190

Table No. 12 contains the composition of Texas cottonseed meal from 1907 to December 31, 1912, averaged in groups according to the crude fiber content. In considering this table, one must bear in mind that the period is one of transition, in which decided improvements were made in the extraction of oil, both in Texas and in other States, and further that the proportionate quantity of prime meal (47 to 51 per cent. protein and fat) is greater during the latter parts of the period, while the proportion of choice (51 to 55 per cent.) is greater during the earlier part. Hence the association of reduced oil content with higher crude fiber content may be due to improved manufacturing conditions and to better chemical control, rather than to the fiber content. The lower fat content is associated with a higher fiber content. However, the table does not show a better extraction as the fiber increases, as increased fiber means more cake, which contains oil. The ratio of protein to fat decreases to 0.184 per cent., then increases, showing a loss of oil due to the additional hulls.

Table No. 13 shows the number of samples in the groups.

TABLE 13.—NUMBER OF SAMPLES OF TEXAS COTTONSEED MEAL, IN GROUPS ACCORDING TO FIBER CONTENTS 1907-1912.

	Below 7% Fat	7 to 8%	8 to 9%	9 to 10%	Over 10%
To 6% fiber	7	49	96	112	168
6–7% fiber	12	71	80	88	99
7–8% fiber	25	81	97	55	57
9–10% fiber	35	59	50	19	10
10–11% fiber	19	48	25	20	10
11–12% fiber	25	20	12	7	7
Over 12% fiber	20	12	5	2	3

TABLE 14.—AVERAGE COMPOSITION OF TEXAS COTTONSEED MEAL IN GROUPS ACCORDING TO FAT CONTENTS.

	No. of Samples	Fat	Crude Fiber	Protein	Nitrogen Free Extract	Water	Ash
July 1, 1914 to Dec. 31, 1914.							
5–6% fat	5	5.68	10.48	44.56	25.28	8.46	5.54
6–7% fat	30	6.73	9.79	44.56	25.88	7.46	5.58
7–8% fat	88	7.54	8.72	45.60	25.29	7.14	5.71
8–9% fat	53	8.46	7.87	46.16	24.89	6.89	5.73
Over 9% fat	32	10.56	8.08	44.69	24.37	6.65	5.65
Jan. 1, 1915 to July 1, 1915.							
5–6% fat	6	5.76	13.02	41.04	26.52	8.15	5.51
6–7% fat	33	6.65	10.46	43.86	25.92	7.50	5.61
7–8% fat	70	7.49	9.22	44.88	25.23	7.43	5.75
8–9% fat	54	8.37	8.79	44.71	24.99	7.22	5.92
Over 9% fat	22	10.22	8.80	44.17	24.16	6.90	5.75
July 1, 1915 to Dec. 31, 1915.							
5–6% fat	19	5.53	13.16	41.31	26.61	7.96	5.39
6–7% fat	84	6.49	11.22	43.44	25.55	7.61	5.51
7–8% fat	97	7.48	10.09	44.30	24.87	7.26	5.57
8–9% fat	36	8.36	9.71	44.16	24.94	7.43	5.56
Over 9% fat	21	9.97	9.80	43.44	24.58	6.71	5.51

Table No. 14 shows the composition of Texas cottonseed meal from July 1, 1914, to December 31, 1915, arranged and averaged according to the fat content. It will be noted that a fat content of 5.68 per cent. is secured with 10.48 per cent. crude fiber in the period from July 1 to December 31, 1914; whereas, in later periods more crude fiber is associated with the low fat content. The second group (6 to 7 per cent. fat) is associated with 9.79 per cent. crude fiber one year, and with a higher content in later years.

TABLE 15.—AVERAGE CONTENTS OF SOUTH CAROLINA COTTONSEED MEAL (1913-1914).

Groups	No. of Samples	Per Cent Protein	Per Cent Fat	Per Cent Crude Fiber
6–7% fat	14	36.80	6.52	12.79
7–8% fat	41	38.23	7.52	10.50
8–9% fat	31	38.72	8.39	9.60
Over 9% fat	24	39.26	10.97	8.31

Table No. 15 shows the composition of South Carolina cottonseed meal as given in their bulletin for 1913-14, arranged and averaged in groups according to the fat content. The lower fat content is associated with a higher crude fiber content.

TABLE 16.—AVERAGE COMPOSITION OF LOUISIANA COTTONSEED MEAL IN GROUP ACCORDING TO FAT CONTENTS 1913-14.

Groups	No. Average	Protein	Fat	Fiber	Nitrogen Free Extract	Water	Ash
6–7% fat	4	39.40	6.68	11.20	27.63	8.09	6.94
7–8% fat	31	40.91	7.52	12.08	27.35	7.94	6.20
8–9% fat	24	38.16	8.38	12.18	27.13	7.75	6.30
Over 9% fat	14	40.03	10.09	11.95	23.71	8.04	6.18

Table No. 16 shows the composition of Louisiana cottonseed meal as given in the bulletin for 1913-14, arranged and averaged in groups according to the fat content. There is no relation between the fat content and the fiber content of the groups. The group with the lowest fat content has the lowest fiber content. The fiber content varies little, from 11.20 to 12.18.

Consideration of the data mentioned leads to the conclusion that it is possible to secure a low oil content of the cake when the crude fiber content is around 7 to 9 per cent., by means of a proper control of the manufacturing processes.

It seems to be somewhat easier, however, to secure a lower oil content when a somewhat larger percentage of crude fiber is present. That is to say, mills which do not exercise such rigid control of their work, reduce the oil content to a greater extent, when a larger amount of crude fiber is present. Under the ordinary manufacturing conditions, somewhat more crude fiber than 9 per cent. may lead to better extraction of oil in many cases. Thus while some mills are able to reduce the oil content to 5.5 per cent. with a fiber content of 8 to 9 per cent. (or even less), other mills seem to get better results when 9 to 11 per cent. is present. This accounts for the differences in opinion of the millers. The difference appears due to manufacturing conditions rather than to crude fiber. Nevertheless, the fact must be taken into consideration that 9 to 11 per cent. crude fiber in some mills appears to give a better extraction of oil. More evidence along this line is needed.

Some oil millers state that the amount of oil left in the cake depends upon the water content of the seed when it is crushed, and is independent of the quantity of hulls present. If the water content is high (8 to 12 per cent.), flinty cake is produced, which is low in oil (5 to 6 per cent.). If the water content is low, a soft cake is produced, which is high in oil and of good color. The water content is to some extent regulated by the conditions of cooking.

RELATION OF CRUDE FIBER CONTENT TO FEEDING VALUE.

Since the fertilizing value of cottonseed meal depends upon its content of nitrogen, available phosphoric acid, and potash, and since the hulls contain little nitrogen, the presence of hulls affects the fertilizing value of cottonseed meal in proportion as it decreases the nitrogen content.

The case is, however, different with the feeding value. The digestibility of the protein and other constituents, except the crude fiber, decreases as the quantity of crude fiber increases.

Cottonseed meal may be considered as being composed of the kernel residue and of the hulls. The kernel residue contains about 3 per cent. crude fiber and the hulls about 45 per cent. The amount of crude fiber is an indication of the amount of hulls present. Bulletin No. 166 contains digestion experiments with cottonseed meal, also with cold-pressed cotton seed and cottonseed meal and hulls. The average cottonseed meal used contains 7.5 per cent. crude fiber. The average quantity of crude fiber in the meal rich in hulls was 26 per cent. Table No. 17 shows the coefficients of digestibility for these separate products.

TABLE 17.—EFFECT OF CRUDE FIBER ON PRODUCTION COEFFICIENT OF THE MEAL.

	Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract
Meal, coefficient of digestibility	86	95	15	72
Meal and hulls coefficient of digestibility	73	91	37	62
Difference for 18.50% crude fiber	13	4	—22	10
Difference for 1% crude fiber	0.7	0.2	1.2	0.5
Difference in production coefficient for 1% crude fiber	—.0016	—.0012	+.003	—.0013

The differences in the coefficients of digestibility are also given. By dividing the differences in digestibility by the differences in the crude fiber, we get the effect of 1 per cent. crude fiber upon the coefficient of digestibility, which is also given in the table. This may be calculated to the productive value. Thus an increase of 1 per cent. crude fiber gives the differences in the table. There is an increase in the productive value of the crude fiber. Using these figures, we have calculated the production coefficients of the various grades of cottonseed meal as given in Table No. 18. (For a discussion of the production coefficients, see Bulletin No. 185.)

TABLE 18.—PRODUCTION COEFFICIENTS OF COTTONSEED MEAL AND COTTONSEED MEAL AND HULLS.

	Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	Coefficient of digestibility of Protein
With 7% crude fiber (6–8).....	0.203	.567	—.033	.181	86.2
With 9% crude fiber (8–10).....	.200	.565	—.027	.178	85.5
With 11% crude fiber (10–12)....	.197	.563	—.021	.175	84.8
With 13% crude fiber (12–14)....	.194	.560	—.015	.172	84.1
With 15% crude fiber (14–16).....	.190	.558	—.009	.170	83.4

Not only does the digestibility of the constituents decrease, but also the actual value to the animal decreases, on account of the increased expenditure of energy involved in the digestion of the crude fiber.

The decrease in productive value is estimated at 1.3 per cent. for each per cent. crude fiber.

An increase of crude fiber from 9 to 11 per cent. with no change in the other constituents will thus decrease the digestibility of the protein 1.6 per cent., and the productive value 2.6 per cent. Thus if two cottonseed meals have the same protein content, the one with the higher crude fiber will contain less digestible protein and have a lower fat-producing value.

It is of some interest to inquire, what proportion of the value of cottonseed meal comes from the different constituents. All the digestible protein, of course, comes from the protein. Table No. 19 contains the productive values calculated from the constituents of two grades of cottonseed meal. The negative value of the fiber is subtracted from the nitrogen-free extract in calculating the percentages.

TABLE 19.—COMPARATIVE PRODUCTIVE VALUES OF CONSTITUENTS OF TWO COTTONSEED MEALS.

	Meal A			Meal B		
	Composition	Productive Value	% of Total	Composition	Productive Value	% of Total
Protein.....	44.0	8.66	51.6	36.0	7.09	44.1
Fat.....	7.0	3.94	23.5	7.0	3.94	24.5
Crude fiber.....	10.0	—.21	.....	11.0	—.23	.....
Nitrogen free extract.....	25.0	4.37	24.8	30.0	5.25	31.3
Total.....	.....	16.76	.....	.....	16.05	

It is seen that from 44 to 51 per cent. of the value of these two extreme grades is in the protein, and that from 69 to 75 per cent. is in the protein and fat combined.

STANDARDS FOR COTTONSEED MEAL.

Standards for cottonseed meal adopted by the different States are as follows: The standards for North Carolina, South Carolina, Georgia and Alabama, have been in use for a number of years.

North Carolina.—Cottonseed meal must contain not less than 7.5 per cent ammonia. This is practically the fertilizer law.

South Carolina.—Under the fertilizer law, cottonseed meal must contain not less than 7 per cent. ammonia. Under the South Carolina feed law, cottonseed meal must contain not less than 36 per cent. protein, 3 per cent. fat, and not more than 10 per cent. crude fiber (7.5 per cent. ammonia equals 36 per cent. protein, closely).

Georgia.—Under the fertilizer law, cottonseed meal must contain not less than 7.5 per cent. ammonia. Under the feed law, the standard adopted for cottonseed meal is 38.62 per cent. protein and 4.00 per cent. fat. The standard for crude fiber as published in the bulletins in 1911 to 1915 was 12 per cent., but in the bulletin published November, 1915, the requirement for crude fiber in cottonseed meal was eliminated.

Alabama.—Under the fertilizer law, cottonseed meal must contain not less than 7.5 per cent. ammonia. When it contains less, it must be sold as cottonseed meal and hulls, or low-grade cottonseed meal.

Texas.—From 1907 to 1916, cottonseed meal had to contain not less than 43 per cent. protein, or 50 per cent. protein and fat combined, and not more than 9 per cent. crude fiber. This has now been changed to not less than 44 per cent. protein, 51 per cent. protein and fat combined, and not over 11 per cent. crude fiber. (See below.)

Oklahoma.—According to a circular of the Oklahoma State Department of Agriculture, October 1, 1915, choice cottonseed meal must contain at least 42 per cent. protein and 5.5 per cent. fat and not more than 9.5 per cent. crude fiber; prime cottonseed meal must contain at least 38 per cent. protein and 5.5 per cent. fat, and not more than 11 per cent. crude fiber, and these standards have been approved by representatives of the Oklahoma Cottonseed Crushers' Association.

Pennsylvania.—The Pennsylvania State law does not permit more than 9 per cent. crude fiber in cottonseed meal.

CHANGE IN THE TEXAS STANDARD FOR COTTONSEED MEAL.

The Texas standard for cottonseed meal from 1907 to 1916 was that it should contain not less than 43 per cent. protein, not less than 50 per cent. protein and fat combined, and not more than 9 per cent. crude fiber.

A hearing on cottonseed products was held by the Feed Control Service on October 2, 1915, and was supplemented by letters submitted later. On February 15, 1916, the agreement given below was made between Director Youngblood and a committee of the Texas Cottonseed Crushers' Association. This agreement practically changes the emphasis in the Texas standard from crude fiber to protein, or protein and fat.

The following memorandum of understanding was agreed to by a committee of the Texas Cottonseed Crushers' Association and accepted by Director B. Youngblood:

"We, the undersigned, acting for and in behalf of the Texas Cottonseed Crushers' Association, have come to an understanding with

the Feed Control Service, on this the 15th day of February, 1916, at College Station, Texas, as follows:

"It is agreed that the definition and standards for cottonseed meal shall more nearly coincide with the rules of the Texas Cottonseed Crushers' Association, as follows:

"Cottonseed meal is composed of decorticated kernels of cotton seed, free from excess of hulls and other foreign materials. It must contain not less than 44 per cent. of protein, or not less than 51 per cent. of protein and fat combined, and not more than 11 per cent. of crude fiber.

"Cottonseed cake shall correspond to cottonseed meal in composition and as to standard.

"It is agreed that any deficiency in percentage of fat may be offset by additional percentage of protein, as, for instance, in cottonseed meal guaranteed to contain 5 per cent. of fat, 46 per cent. of protein would be required.

"It will be observed that the 51 per cent. of protein and fat combined coincides identically with the rule of the Texas Cottonseed Crushers' Association, and that the increase of 2 per cent. crude fiber gives the millers greater latitude in holding the standard for protein and fat.

"It is agreed that the standard for *choice cottonseed meal* shall remain as heretofore."

This committee consisted of Mr. B. W. Couch, President of the Texas Cottonseed Crushers' Association; Mr. Ed. Woodall, of Hillsboro, Texas, and Mr. W. F. Pendleton, of Farmersville, Texas, and Durant, Oklahoma.

While we have reason to believe that the majority of Texas cottonseed crushers are in favor of the agreement given above, and are satisfied with the definition now adopted, as shown by the definition adopted at their meeting in May, 1916, yet there are some few cottonseed crushers who desire to put on the Texas market a decidedly inferior product, containing less than 44 per cent. protein and correspondingly more hulls, under the name of cottonseed meal, and are not satisfied with the standard agreed upon. The Feed Control Service does not attempt to regulate what shall or shall not be manufactured in the State, but merely insists on the right of the purchaser to know what he is buying. Those desiring the lower standard, say that if the low grade product is sold under the name of cottonseed meal and hulls, that they cannot get as much for it as if it were sold as cottonseed meal. If this argument means anything, it means that the buyer will not pay as much for the goods if he knows what he is getting, as he would if he thought he was getting cottonseed meal. This is, thus, an argument in favor of the proper naming of the product, and not against it.

DEFINITIONS OF COTTONSEED MEAL.

UNITED STATES FEED CONTROL OFFICIALS.

The following definition of cottonseed meal has been adopted by the Feed Control Officials of the United States:

Cottonseed Meal is a product of the cottonseed only, composed principally of the kernel with such portion of the hull as is necessary in the manufacture of oil; provided, that nothing shall be recognized as cottonseed meal that does not conform to the foregoing definition and that does not contain at least 36 per cent. of protein.

Choice Cottonseed Meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least 41 per cent. of protein.

Prime Cottonseed Meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and must contain at least 38.6 per cent. of protein.

Good Cottonseed Meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, and must contain at least 36 per cent. of protein.

Cottonseed Feed is a mixture of cottonseed meal and cottonseed hulls containing less than 36 per cent. of protein.

INTERSTATE COTTONSEED CRUSHERS' DEFINITIONS.

The definitions (1915) adopted by the Interstate Cottonseed Crushers' Association are as follows:

Cottonseed Meal is a product of the cottonseed only, composed principally of the kernel, with such portion of the fiber or hull and oil as may be left in the ordinary course of manufacture, or as may be indicated by the analysis thereof, and shall be graded and classed as follows:

Provided, that nothing shall be recognized, traded in or sold as cottonseed meal that does not conform to the requirements above set forth, and that does not contain at least 36 per cent. of protein.

Choice Cottonseed Meal must be finely ground, not necessarily bolted, perfectly sound and sweet in odor, yellow, free from excess of lint, and by analysis must contain at least either 8 per cent. of ammonia, or 49 per cent. of combined protein and fat.

Prime Cottonseed Meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, yellow, not brown or reddish, free from excess of lint, and by analysis must contain at least either 7.5 per cent. of ammonia or 46 per cent. of combined protein and fat.

Good Cottonseed Meal must be finely ground, not necessarily bolted, of sweet odor, reasonably bright in color, and by analysis must contain at least either 7 per cent. of ammonia, or 43 per cent. of combined protein and fat.

Cottonseed cake not coming up to contract analysis shall be a good delivery if within one-quarter of 1 per cent. of ammonia, or within 1¼ per cent. of combined fat and protein, guaranteed by contract or of sale sample, but the settlement price shall be reduced at the rate of one-tenth of contract price for each 1 per cent. and proportionately for fractions of deficiency in ammonia, or one forty-ninth, one forty-sixth, or one forty-third, as the case may be, for deficiency in protein and fat.

Where cake is sold on sample, to be a good delivery it must reasonably conform to the sale sample in color and texture and analysis.

TEXAS FEED CONTROL SERVICE DEFINITIONS.

The definitions of the Texas Feed Control Service are now as follows:

Cottonseed Meal is composed of the decorticated kernels of cotton seed, free from excess of hulls and other foreign materials. It must contain not less than 44 per cent. of protein, not less than 51 per cent. of protein and fat combined, and not more than 11 per cent. of crude fiber.

Prime Cottonseed Meal is composed of the decorticated kernels of cotton seed, free from excess of hulls and other foreign materials. Must be finely ground, of sweet odor, reasonably bright in color, and must contain not less than 44 per cent. of protein, 7 per cent. of fat (not less than 51 per cent. of protein and fat combined), and not more than 9 per cent. of crude fiber.

Choice Cottonseed Meal is composed of the decorticated kernels of cotton seed, free from excess of hulls and other materials. Must be finely ground, of sweet odor, reasonably bright in color, and must contain not less than 48 per cent. of protein, 7 per cent. of fat (not less than 55 per cent. of protein and fat combined), and not more than 9 per cent. of crude fiber.

Cottonseed Cake should correspond to cottonseed meal in composition.

Cottonseed Meal and Hulls is any mixture of cottonseed meal and hulls containing not less than 9 per cent. and not more than 20 per cent. of crude fiber.

Mixed Cottonseed Meal and Hulls is any mixture of cottonseed meal and hulls containing not less than 20 per cent. and not more than 40 per cent. of crude fiber. The percentage of hulls must be stated.

TEXAS COTTONSEED CRUSHERS' ASSOCIATION DEFINITIONS.

The definitions of the Texas Cottonseed Crushers' Association are as follows:

Cottonseed Cake is a product of the cottonseed only, composed principally of the kernel, with such portion of the fiber or hull and oil as may be left in the ordinary course of manufacture, or as may be in-

dicated by the analysis thereof, and shall be graded and classed as follows:

Provided, that nothing shall be recognized, traded in or sold as cottonseed cake that does not conform to the requirements above set forth, and that does not contain at least 36 per cent. of protein; and further provided, that no cottonseed cake shall be offered for sale, for consumption in Texas, that does not comply with the State pure feed laws.

Choice Cottonseed Cake must be reasonably bright in color, sweet in odor, friable in texture, not burnt in cooking, free from excess of lint and hulls, and shall contain by analysis of a competent chemist 55 per cent. of protein and fat combined; provided, that it shall not be rejected it if contains as much as 51 per cent. of protein and fat combined; but an allowance shall be made by seller of one-fifty-fifth of the contract price less freight when sold delivered for each deficient unit of protein and fat combined.

Prime Cottonseed Cake must be of good color, yellowish, not brown or reddish, sweet in odor, firm in texture, free from excess of lint, and shall contain by analysis of a competent chemist 51 per cent. of protein and fat combined; provided, that it shall not be rejected if it contains as much as 47 per cent. of protein and fat combined; but an allowance shall be made by the seller of one-fifty-first of the contract price less freight when sold delivered for each deficient unit of protein and fat combined.

Sec. 2B. Cottonseed cake where sold for consumption in Texas shall contain not less than 44 per cent. of protein, or 51 per cent. of protein and fat combined, and must not contain more than 11 per cent. of fibre.

No claim for deficiency of protein and fat combined shall be made by buyer unless the variation shall equal or exceed one-half of one unit.

Cottonseed Meal is a product of the cottonseed only, composed principally of the kernel, with such portion of the fiber or hull and oil as may be left in the ordinary course of manufacture, or as may be indicated by the analysis thereof, and shall be graded and classed as follows:

Provided, that nothing shall be recognized, traded in or sold as cottonseed meal that does not conform to the requirements above set forth, and that does not contain at least 36 per cent. of protein; and further provided, that no cottonseed meal shall be offered for sale, for consumption in Texas, that does not comply with the State pure feed laws.

Cottonseed meal shall be graded as follows:

Choice Cottonseed Meal must be the product of sound cottonseed cake, finely ground, reasonably bright in color, not brown or reddish, free from excess of lint and hulls, and shall contain by analysis of a competent chemist 55 per cent. of protein and fat combined; provided, that it shall not be rejected if it contains as much as 51 per cent. of protein and fat combined; but an allowance shall be made by seller of one-fifty-fifth of the contract price less freight when sold delivered for each deficient unit of protein and fat combined.

Choice Bolted Cottonseed Meal must be the product of sound cot-

tonseed cake, finely ground and bolted, of bright yellow color, not brown or reddish, and shall contain by analysis of a competent chemist 55 per cent. protein and fat combined; provided, that it shall not be rejected if it contains as much as 51 per cent. of protein and fat combined; but an allowance shall be made by seller of one-fifty-fifth of the contract price less freight when sold delivered for each deficient unit of protein and fat combined. Meal to be *choice bolted* must be ground and bolted sufficiently fine for the contents to pass through a wire mesh of one-twenty-sixth of an inch in diameter.

Prime Cottonseed Meal must be the product of sound cottonseed cake, finely ground, of sweet odor, reasonably bright in color, not brown or reddish, reasonably free from excess of lint, and shall contain by analysis of a competent chemist 51 per cent. of protein and fat combined; provided, that it shall not be rejected if it contains as much as 47 per cent. of protein and fat combined; but an allowance shall be made by seller of one-fifty-first of the contract price, less freight where sold delivered, for each deficient unit of protein and fat combined.

Prime Bolted Cottonseed Meal must be the product of sound cottonseed cake, finely ground and bolted, of bright yellow color, not brown or reddish, and shall contain by analysis of a competent chemist 51 per cent. of protein and fat combined; provided, it shall not be rejected if it contains as much as 47 per cent. of protein and fat combined; but an allowance shall be made by seller of one-fifty-first of the contract price, less freight when sold delivered, for each deficient unit of protein and fat combined. Meal to be *prime bolted* must be ground and bolted sufficiently fine for the contents to pass through a wire mesh of one-twenty-fourth of an inch in diameter.

Sec. 4B. Cottonseed meal, where sold for consumption in Texas, shall contain not less than 44 per cent. of protein or 51 per cent. of protein and fat combined and must not contain more than 11 per cent of fiber.

No claim for deficiency of protein and fat combined shall be made by buyer unless the variation shall equal or exceed one-half of one unit.

PROTEIN REGULATION.

The valuation of different cottonseed meals by means of the protein, or protein and fat content, was adopted for the purpose of distinguishing between different grades of cottonseed meal, made by processes which had for their primary object the extraction of the oil. The meal varied in composition, both on account of differences in the seed, and differences in the hull content, due to imperfections in manufacturing. With the development of this method of valuation, and with the development of chemical methods of mill control, the manufacturer found that, though he was in many cases penalized for meal running below the guarantee, he received no extra payment when meal was above guarantee. He thus formed the impression that the ammonia (or protein) and fat was the only valuable constitutent of the feed, and the remainder of the feed had little or no value. In other words, he was selling protein or protein and fat. These con-

siderations lead naturally to introduction of hulls during the process of manufacture, where needed to run the protein content down to the minimum guarantee. Where the protein, or protein content served only as a basis for judging the quality of meal, questions as to the hull content, or whether the product was really a cottonseed meal, did not often arise. The rules of the Interstate and other Cottonseed Crushers' Associations in fact permit the addition of cottonseed hulls or hull-bran, either during the process of manufacture or otherwise. This attitude is further brought out in the following statement:

H. E. Hawk, in Oil Mill Superintendents' Association, June, 1913, says:

"As in our State we have a standard of 7.50 per cent., and the mill sells on that basis, we should be able to control the ammonia, within 10-100 per cent. of the 1 per cent. Otherwise the man that buys the meal or cake, if over 10-100 per cent. short will have a kick coming to him, and will be entitled to a reduction. On the other hand, if the mill sells meal for 7½ per cent. ammonia, and it runs anywhere 7.60 per cent. to 7.75 per cent., the mill will be the loser of 30 cents for 7.60 per cent. up to 75 cents for 7.75 per cent. per ton of meal. This will be, as you can readily see, either a loss to the mill in getting its final settlements on meal sold if the ammonia runs too low, and, if on the other hand, the ammonia runs high it will be a great loss in running a higher value than it is sold for. In view of these facts, it is best to have the analysis often and to get a basis of standard in operation, then run to the standard constantly. This is accomplished by seeing that the linting is uniform, the hullers are kept sharp so that the hulling will be constantly uniform. That is, they must do their work constantly the same, then the separation to get the proper proportion of hull meal and this latter must be fine and free of lint, with the proper percentage to obtain, say, in amount of cake that will run the per cent. of ammonia just where you want it (and this, I say, can be done very easily if the equipment is right), then to take your samples of cooked meal, watch very closely the time, the temperature, in the progress of your cooking, get the smell, the feel, and the color the exact shade."

The Picard-Law Company, in The Oil Miller, December, 1914, states:

"Georgia shows an average of 7.16 per cent. ammonia in spite of the fact that a large percentage of the mills are shipping 7 per cent. cake. As near as we can figure it, the meal from this State has averaged 0.20 per cent. in ammonia above guarantee. At $2.50 per unit this is 50 cents per ton excess value. Basing the meal sold during this time at 50,000 tons, the Georgia mills have given away $25,000.00 worth of protein in an effort to keep their product up to the standard."

The Picard-Law Company, in The Oil Miller, February, 1914, states:

"The time is coming and coming fast when the mill that does not have daily analyses made of meal cannot keep up with the procession. It is the only way to regulate ammonia. It would surprise many mill managers to know that we can pick out nearly any day in the season

and show that the seed handled in our laboratory that day would produce meal varying as much as 1 per cent. in ammonia when exactly the same number of pounds are made per ton. This might happen in your mill any time that you change from one car to another.

"This may sound like taking advantage of our opportunity to pull for business, but if you will consider the matter carefully you will be convinced that you and not the chemist will be the big gainer. By regulating ammonia within ten points a two-press mill can often save enough in a couple of weeks to pay for analytical work the whole season. That the big companies realize this is proven by the fact that over thirty independent mills in Georgia, besides the corporation mills, have their products analyzed each day that they operate."

D. C. Picard, Alabama Cottonseed Crushers, in The Oil Miller, September, 1915, states:

"Most of you think, I am sure, that the sum total of 'getting results' is good separation and a low standard of press work, but to my mind one of the most important factors of all in making profits is close control of the ammonia. Of course, with seed of variable ammonia content, it is rather difficult to keep the ammonia constant by regulation at the second huller. Of late, a third huller has been installed in some mills for the sole purpose of controlling ammonia, which makes it somewhat easier; but, even with this, daily analyses of the cake is necessary.

"I wonder how many realize how large a loss this is; sometimes it is greater than allowing excess of oil to remain in the cake. One ton of 7½ per cent. meal contains 150 pounds of ammonia, which is worth (since the value of the meal is in its ammonia), when meal is selling for $28.00 per ton, very close to 20 cents per pound. If the meal is sold on this guarantee, but actual delivery runs 7.75 per cent., five extra pounds of ammonia are thrown in with each ton, making the customer a present of $1.00 per ton. This is very nice for the customer, but downs the mill's profits quite a lot. It does not hit the bank-balance directly, like reclamations, but, nevertheless, when the books are closed several thousands of dollars are usually debited to excess values. Much of this can be prevented by the daily analyses above mentioned so that when shipments are made high and low ammonia meal can be mixed to make a close average. This has been done; it is entirely practical. Of course, if meal could always be sold, as it should be, on its ammonia, this would not be necessary, but we must meet conditions as we have them.

"To show you how excess ammonia figures in comparison with excess oil: The average oil mill tries to keep oil in the cake down to 6 per cent., or 120 pounds to the ton. If the oil runs 7 per cent., this will be 140 pounds. The extra 20 pounds of oil at 5½ cents per pound is worth $1.10 per ton, *so you see the giving away of one-quarter of a per cent. of excess ammonia is practically equivalent to allowing 1 per cent. excess oil remain in the cake.*

"Some of you may say: 'We cannot control our ammonia.' But,

yes you can! If you will use your chemists properly you soon get 'results.'"

The manufacturer of cottonseed oil has sometimes to contend with seed low in protein (or ammonia), or delinted so closely that separation is difficult, and has trouble in producing meal of the standard, if it is not too low. Sometimes separation of kernels from seed must, to some extent, be sacrificed, to produce the grade of meal desired.

While the manufacturer may be willing to sacrifice separation to come up to his guarantee in protein, when necessary to do so, he is not willing to sacrifice it to come up to a guarantee in crude fiber when it is not necessary to come up to his guarantee in protein. Protein, or protein and fat, is undoubtedly the most valuable constituent of cottonseed meal, and the manufacturer feels that when he suffers the burden of low protein seed, he should receive the recompense of high protein seed when it comes his way.

CRUDE FIBER STANDARD.

The definition of cottonseed meal adopted by the Feed Control Officials of the United States is as follows:

"Cottonseed meal is a product of the cotton seed only, composed principally of the kernel with such portion of the hull as is necessary in the manufacture of the oil; provided, that nothing shall be recognized as cottonseed meal that does not conform to the foregoing definition and that does not contain at least 36 per cent of protein."

We will inquire how much crude fiber represents "such portion of the hull as is necessary to the manufacture of the oil." This point is difficult to decide on the basis of analytical results alone.

The analyses given in Tables Nos. 3, 5, 6 and 7 show the average crude fiber content. Standards, however, must be above rather than below the maximum.

In the case of cottonseed meal, samples with low crude fiber may have had it reduced for the purpose of raising the protein. On the other hand, those with high crude fiber may have had it added, during the process of manufacture or otherwise, for the purpose of reducing the protein.

Then, also, there are certain varieties of cotton of which the seed are partly bare, like Sea Island seed. The hulls do not felt together, and are not easily removed.

Some millers also claim that a rather large amount of hulls is necessary to give drainage and reduce the oil; while other millers say that only a much smaller quantity is needed. This has been already discussed. Apparently a better extraction of oil is often accompanied by a higher percentage of hulls.

TABLE 20.—DISTRIBUTION OF FIBER CONTENTS OF COTTONSEED MEAL.

	Below 9.1	9.1 to 10.1	10.1 to 11.1	11.1 to 12.1	Over 12.1	Total
South Carolina M 1914	37	16	22	20	14	109
Georgia, 1915	25	10	5	2	1	43
Pennsylvania 265—1914	24	23	24	14	9	94
New York, 1911	14	8	2	2	.....	26
New York, 1912	34	2	.....	.....	.....	36
New York, 1913	24	8	2	.....	.....	34
New York, 1914	2	10	4	2	.....	18
New York, 1915	11	11	.....	.....	1	23
New Jersey, 1913–14	7	6	.....	1	.....	14
New Jersey, 1914–15	14	4	1	1	.....	20
Kentucky, 1914	22	26	13	11	9	80
Georgia, 1911–12	4	4	.....	.....	.....	17
Georgia, 1912–13	14	4	2	0	11	31
Georgia, 1913–15	24	11	5	2	3	45
Louisiana, 1913–14	22	26	3	23	4	78

Table No. 20 shows the distribution of the fiber contents of cottonseed meals as analyzed in several States. Samples illegal in protein content were omitted. A large proportion of the samples contained 9 per cent. crude fiber, or less.

TABLE 21.—GUARANTEES OF CRUDE FIBER IN COTTONSEED MEAL.

	9 or less	9.1–10	10.1–11	11.1–12	Over 12.1
Kentucky, 1914 (185)	4	17	1	1	1
New York, 1915 (404)	1	9	4	5	2
Indiana, 1914 (177)	5	24	3	10	5
South Carolina, 1915 (52)	6	11	5	90	0
Louisiana (1913–14)	22	21	6	26	4

Table No. 21 shows the guarantees of crude fiber made in five States. With the exception of South Carolina, the bulk of the guarantees is far less than 10.1 per cent. crude fiber.

TABLE 22.—AVERAGE FIBER CONTENT OF COTTONSEED MEALS (CALCULATED BY LAW).

	Pound per ton	Ammonia %	Fiber %	Pound per ton	Ammonia %	Fiber %
September—		1911			1912	
Total	943	7.25	11.10	888	7.12	7.60
October—		1911			1912	
Total	888	7.66	10.40	842	7.33	7.68
Georgia	865	7.73	9.88	833	7.30	9.22
North Carolina	904	7.75	9.78	853	7.35	8.70
South Carolina	950	7.37	12.32	830	7.55	8.19
Alabama	855	7.66	9.18	820	7.32	7.91
November—		1911			1912	
Total	880	7.71	10.23	838	7.62	8.59
Georgia	851	7.79	9.33	809	7.75	7.77
North Carolina	915	7.85	8.90	852	7.60	7.53
South Carolina	920	7.45	11.46	859	7.43	9.05
Alabama	883	7.48	10.84	837	7.56	10.04
December—		1911			1912	
Total	884	7.78	10.39	884	7.50	10.95
Georgia	865	7.84	9.96	882	7.46	11.15
North Carolina	910	7.93	10.13	859	7.70	11.06
South Carolina	950	7.42	10.50	933	7.46	11.34
Alabama	865	7.77	9.93	859	7.50	10.80

TABLE 22.—AVERAGE FIBER CONTENT OF COTTONSEED MEALS (CALCULATED BY LAW).

	Pound per ton	Ammonia %	Fiber %	Pound per ton	Ammonia %	Fiber %
		1912			1913	
January—						
Total	885	7.81	9.82	900	7.44	11.44
Georgia	851	7.88	8.58	900	7.40	11.86
North Carolina	927	7.75	10.67	893	7.66	10.73
South Carolina	938	7.59	11.54	876	7.33	9.94
Alabama	860	7.84	9.20	890	7.38	11.92
		1912			1913	
February—						
Total	887	7.78	10.21	887	7.48	10.77
Georgia	850	7.87	9.27	873	7.44	10.70
North Carolina	903	7.85	10.66	888	7.63	9.88
South Carolina	904	7.62	10.98	883	7.42	10.57
Alabama	860	7.82	9.68	885	7.58	11.20
		1912			1913	
March—						
Total	878	7.79	10.36	886	7.51	10.72
Georgia	853	7.84	9.82	858	7.53	11.26
North Carolina	902	7.92	9.66	911	7.57	10.46
South Carolina	955	7.62	12.34	925	7.31	11.50
Alabama	860	7.75	9.72	858	7.59	9.13
		1912			1913	
Average	892	7.71	10.22	869	7.48	9.98
Highest in fiber	955	7.62	12.34	900	7.40	11.86
Lowest in fiber	851	7.88	8.58	852	7.60	7.53

Table No. 22 shows the estimated yield, the average protein, and the calculated crude fiber, averaged by months for several States of the Southeast as presented by Mr. Law in The Oil Miller, June, 1913. The crude fiber was calculated on the basis of 3 per cent. in the expressed kernels, and 50 per cent. in the hulls.

TABLE 23.—AVERAGE ANALYSIS OF COTTONSEED AND COTTONSEED CAKE.

Collected by G. E. Bidwell, 1913-14. Analysts: Fraps, Texas; Bidwell, U. S. Dept. Agr.; Kellogg, Pa.; Cathcart, N. J.; Smith, Mass. Analysis of Seed Computed from Analysis of Hulls and Meats.

Name and Address of Manufacturer.	No.		Protein	Fat	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent in Seed
*North Carolina Cotton Oil Co., Raleigh, N. C.	18201H	Seed	19.49	23.10	19.43	27.51	6.55	3.92	.....
		Meats	31.43	39.39	1.87	16.96	5.50	4.85	58
		Hulls	2.99	0.60	43.69	42.07	8.00	2.65	42
	18202H	Cake	38.83	7.33	10.79	30.78	6.00	6.27	.....
North Carolina Cotton Oil Co., Wilmington, N. C.	18204H	Seed	19.49	22.99	19.42	27.68	6.55	3.87	.....
		Meats	31.35	39.14	1.76	17.42	5.50	4.83	58
		Hulls	3.12	0.68	43.80	41.86	8.00	2.54	42
	18205H	Cake	36.14	6.52	13.34	31.96	6.00	6.04	.....
Swift & Co., Columbus, S. C.	18206H	Seed	20.27	23.42	18.04	28.12	6.51	3.64	.....
		Meats	32.06	38.99	1.78	17.18	5.50	4.49	59.5
		Hulls	2.93	0.54	41.93	44.20	8.00	2.40	40.5
	18207H	Cake	34.43	5.85	15.47	32.66	6.00	5.59	.....
South Carolina Cotton Oil Co., Columbus, S. C.	18208H	Seed	19.12	23.64	18.56	28.49	6.54	3.65	.....
		Meats	30.64	40.00	1.84	17.47	5.50	4.55	58.5
		Hulls	2.88	0.59	42.12	44.03	8.00	2.38	41.5
	18209H	Cake	34.70	6.50	13.96	32.94	6.00	5.90	.....
Southern Cotton Oil Co., Savannah, Ga.	18210H	Seed	19.85	22.55	20.01	27.42	6.56	3.61	.....
		Meats	32.22	38.76	1.83	17.12	5.50	4.57	57.5
		Hulls	3.11	0.60	44.61	41.38	8.00	2.30	42.5
	18211H	Cake	38.63	8.20	10.93	30.03	6.00	6.21	.....
Empire Cotton Oil Co., Valdosa, Ga.	18212H	Seed	20.57	22.14	19.33	27.86	6.55	3.55	.....
		Meats	33.36	37.78	1.78	17.19	5.50	4.39	58
		Hulls	2.91	0.55	43.57	42.60	8.00	2.37	42
	18213H	Cake	35.87	6.14	14.32	31.99	6.00	5.68	.....
Peoples Cotton Oil Co., Selma, Ala.	18224H	Seed	19.53	23.23	18.25	28.07	6.54	3.70	.....
		Meats	31.39	39.39	1.94	17.21	5.50	4.57	58.5
		Hulls	2.83	0.46	41.26	44.98	8.00	2.47	41.5
	18227H	Cake	39.18	6.21	13.69	29.11	6.00	5.81	.....
Selma Oil, Ice and Fertilizer Co., Selma, Ala.	18228H	Seed	20.94	21.31	19.89	27.47	6.58	3.85	.....
		Meats	34.43	37.07	1.89	16.25	5.50	4.86	57
		Hulls	2.96	0.41	43.74	42.38	8.00	2.51	43
	18229H	Cake	38.51	5.95	14.03	29.47	6.00	6.04	.....
Alabama Cotton Oil Co., Selma, Ala.	18230H	Seed	21.20	21.46	19.47	27.52	6.54	3.81	.....
		Meats	33.99	36.37	1.82	17.68	5.50	4.64	58.5
		Hulls	3.17	0.43	44.37	41.38	8.00	2.65	41.5
	18231H	Cake	36.54	6.24	16.39	29.40	6.00	5.43	.....
†Refuge Cotton Oil Co., Vicksburg, Miss.	18232H	Seed	20.86	23.36	19.83	25.03	6.50	4.42	.....
		Meats	32.70	38.57	1.94	15.65	5.50	5.64	60
		Hulls	3.09	0.56	46.68	39.07	8.00	2.60	40
	18233H	Cake	41.72	9.27	10.22	25.35	6.00	7.44	.....

Southern Cotton Oil Co., Memphis, Tenn	18234H	Seed	21.14	22.01	19.69	26.46	6.53	4.17	.....
		Meats	33.69	36.99	2.02	16.47	5.50	5.33	59
		Hulls	3.07	0.47	45.13	40.81	8.00	2.52	41
	18235H	Cake	39.53	6.82	12.09	28.78	6.00	6.78	.....
Perkins Oil Co., Memphis, Tenn	18236H	Seed	20.39	23.19	18.79	26.88	6.51	4.24	.....
		Meats	32.20	38.51	1.85	16.50	5.50	5.44	59.5
		Hulls	3.04	0.69	43.68	42.13	8.00	2.46	40.5
	18237H	Cake	40.96	7.33	9.59	29.10	6.00	7.02	.....
‡Florida Manufacturing Co., Madison, Fla	18214H	Seed	19.02	22.46	17.27	30.57	6.54	4.14	.....
		Meats	29.98	38.04	1.97	19.24	5.50	5.27	58.5
		Hulls	3.56	0.50	38.84	46.55	8.00	2.55	41.5
	18215H	Cake	23.61	7.12	20.25	38.15	6.00	4.87	.....
Marion Harper Cotton Oil Co., Atlanta, Ga	18216H	Seed	19.74	23.34	18.27	28.43	6.51	3.71	.....
		Meats	31.17	38.90	1.79	18.19	5.50	4.45	59.5
		Hulls	2.93	0.46	42.47	43.52	8.00	2.62	40.5
	18217H	Cake	33.55	5.61	15.19	34.06	6.00	5.59	.....
Swift & Co., Atlanta, Ga	18218H	Seed	20.18	22.24	19.37	28.07	6.55	3.59	.....
		Meats	32.68	38.00	1.83	17.68	5.50	4.31	58
		Hulls	2.92	0.48	43.60	42.41	8.00	2.59	42
	18219H	Cake	38.10	5.67	12.75	31.77	6.00	5.71	.....
Southern Cotton Oil Co., Montgomery, Ala	18220H	Seed	20.97	21.83	19.58	27.33	6.55	3.74	.....
		Meats	33.91	37.30	1.75	16.94	5.50	4.60	58
		Hulls	3.10	0.48	44.20	41.68	8.00	2.54	42
	18221H	Cake	36.78	6.70	13.63	31.30	6.00	5.59	.....
Alabama Cotton Oil Co., Montgomery, Ala	18222H	Seed	21.60	21.74	18.07	28.13	6.54	3.92	.....
		Meats	34.38	36.61	1.83	16.74	5.50	4.94	58.5
		Hulls	3.59	0.78	40.96	44.18	8.00	2.49	41.5
	18223H	Cake	35.15	6.25	13.86	33.08	6.00	5.66	.....
Newton County Cotton Oil Co., Covington, Ga	18225H	Seed	21.77	21.11	19.91	26.87	6.56	3.78	.....
		Meats	35.59	36.35	1.76	16.19	5.50	4.61	57.5
		Hulls	3.08	0.49	44.48	41.30	8.00	2.65	42.5
	18226H	Cake	38.64	7.73	9.92	31.73	6.00	5.98	.....
Lookout Refining Co., Chattanooga, Tenn	18238H	Seed	21.94	21.20	19.89	26.84	6.56	3.57	.....
		Meats	35.89	36.54	1.70	16.01	5.50	4.36	57.5
		Hulls	3.06	0.44	44.49	41.52	8.00	2.49	42.5
	18239H	Cake	41.98	7.16	10.71	28.95	6.00	5.70	.....
Calhoun Oil and Fertilizer Co., Calhoun, Ga	18242H	Seed	21.25	21.40	19.50	27.81	6.58	3.46	.....
		Meats	34.87	37.15	1.91	16.32	5.50	4.25	57
		Hulls	3.21	0.51	42.82	43.04	8.00	2.42	43
	18243H	Cake	40.72	5.73	11.63	30.35	6.00	5.57	.....
Southern Cotton Oil Co., Charlotte, N. C	18246H	Seed	19.95	23.67	18.04	27.98	6.51	3.85	.....
		Meats	31.53	39.40	1.77	17.13	5.50	4.67	59.5
		Hulls	2.95	0.56	41.95	43.90	8.00	2.64	40.5
	18247H	Cake	38.73	6.55	12.15	30.33	6.00	6.24	.....
De Soto Cotton Oil Co., Memphis, Tenn	27401K	Seed	22.11	20.66	20.20	26.00	6.56	4.47	.....
		Meats	35.66	35.48	1.93	15.89	5.50	5.54	57.5
		Hulls	3.79	0.61	44.92	39.67	8.00	3.01	42.5
	27402K	Cake	42.88	8.89	8.22	27.34	6.00	6.67	.....

*Seed somewhat heated.
†This mill makes soft cakes which will probably run high in oil.
‡Sea Island Seed. Last of season with poor seed.

TABLE 23.—AVERAGE ANALYSIS OF COTTONSEED AND COTTONSEED CAKE—Continued.

Collected by G. E. Bidwell, 1913-14 Analysts: Ffaps, Texas; Bidwell, U. S. Dept. Agr.; Kellogg, Pa.; Cathcart, N. J.; Smith, Mass. Analysis of Seed Computed from Analysis of Hulls and Meats.

Name and Address of Manufacturer.	No.		Protein	Fat	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent in Seed
Union Seed and Fertilizer Co., Memphis, Tenn	27403K	Seed	21.57	20.36	20.74	26.59	6.58	4.16	
		Meats	35.21	35.27	1.82	16.87	5.50	5.28	57
		Hulls	3.49	0.61	45.81	39.42	8.00	2.67	43
	27404K	Cake	42.86	7.90	9.46	27.04	6.00	6.74	
Little Rock Cotton Oil Co., Little Rock, Ark	27405K	Seed	22.01	20.42	20.46	26.70	6.55	3.86	
		Meats	35.76	34.83	2.05	16.95	5.50	4.91	58
		Hulls	3.03	0.53	45.88	40.15	8.00	2.41	42
	27406K	Cake	45.58	7.47	7.63	26.51	6.00	6.81	
Southern Cotton Oil Co., Little Rock, Ark	27407K	Seed	22.24	20.96	19.05	27.18	6.53	4.04	
		Meats	35.43	35.10	1.98	16.91	5.50	5.08	59
		Hulls	3.27	0.62	43.62	41.96	8.00	2.53	41
	27408K	Cake	44.42	6.65	8.95	27.23	6.00	6.75	
Morrilton Cotton Oil Co., Morrilton, Ark	27409K	Seed	20.60	18.15	23.12	27.27	6.69	4.17	
		Meats	36.17	34.07	1.96	16.97	5.50	5.33	52.5
		Hulls	3.39	0.55	46.51	38.66	8.00	2.89	47.5
	27410K	Cake	39.36	5.99	11.93	30.24	6.00	6.48	
Conway Cotton Oil Co., Conway, Ark	27411K	Seed	21.37	20.11	21.21	26.84	6.59	3.88	
		Meats	35.44	35.15	1.94	17.03	5.50	4.94	56.5
		Hulls	3.11	0.58	46.24	39.56	8.00	2.51	43.5
	27412K	Cake	43.50	7.24	9.43	27.18	6.00	6.65	
Oklahoma Cotton Oil Co., Oklahoma City, Okla	27413K	Seed	23.65	19.65	21.53	25.27	5.58	3.32	
		Meats	39.12	33.98	1.85	15.40	5.50	4.15	57
		Hulls	3.13	0.64	47.62	38.41	8.00	2.20	43
	27414K	Cake	45.08	7.07	10.16	26.60	6.00	5.09	
American Ice and Oil Co., Oklahoma City, Okla	27415K	Seed	23.85	21.08	19.70	25.35	6.50	3.52	
		Meats	37.74	34.82	1.68	15.90	5.50	4.36	60
		Hulls	3.02	0.47	46.71	39.54	8.00	2.26	40
	27416K	Cake	28.23	8.55	22.28	30.65	6.00	4.29	
Southwestern Cotton Oil Co., Oklahoma City, Okla	27417K	Seed	23.85	20.47	19.77	26.07	6.53	3.31	
		Meats	38.37	34.38	1.74	15.97	5.50	4.04	59
		Hulls	2.96	0.45	45.70	40.62	8.00	2.27	41
	27418K	Cake	39.71	6.77	13.41	28.86	6.00	5.25	
Durant Cotton Oil Co., Durant, Okla	27419K	Seed	22.86	18.78	22.64	25.63	6.63	3.46	
		Meats	39.02	33.68	1.79	15.60	5.50	4.36	55
		Hulls	3.12	0.57	48.13	37.83	8.00	2.35	45
	27420K	Cake	44.04	6.57	10.70	27.40	6.00	5.29	
Elk City Cotton Oil Co., Elk City, Okla	27421K	Seed	23.72	21.09	18.72	26.57	6.51	3.39	
		Meats	37.74	35.09	1.70	15.94	5.50	4.03	59.5
		Hulls	3.10	0.53	43.73	42.19	8.00	2.45	40.5
	27422K	Cake	42.00	6.69	11.98	28.24	6.00	5.09	

Wheeler Cotton Oil Co., Shamrock, Texas	27423K	Seed	24.05	21.02	18.36	26.60	6.50	3.47	
		Meats	38.07	34.77	1.92	15.63	5.50	4.11	60
		Hulls	3.02	0.40	43.02	43.05	8.00	2.51	40
	27424K	Cake	46.95	6.38	9.03	26.31	6.00	5.33	
Memphis Cotton Oil Co., Memphis, Texas	27425K	Seed	24.32	20.37	18.88	26.34	6.53	3.56	
		Meats	39.08	34.17	1.82	15.11	5.50	4.32	59
		Hulls	3.08	0.52	43.43	42.51	8.00	2.46	41
	27426K	Cake	48.91	7.66	7.19	24.65	6.00	5.59	
Quanah Cotton Oil Co., Quanah, Texas	27427K	Seed	24.52	20.59	19.02	25.75	6.50	3.62	
		Meats	38.78	34.01	1.82	15.47	5.50	4.42	60
		Hulls	3.12	0.46	44.83	41.17	8.00	2.42	40
	27428K	Cake	45.75	7.09	9.40	26.11	6.00	5.65	
Riverside Cotton Oil Co.,	27429K	Seed	24.29	21.81	17.77	26.26	6.48	3.39	
		Meats	37.76	35.40	1.77	15.58	5.50	3.99	61
		Hulls	3.23	0.57	42.79	42.95	8.00	2.46	39
	27430K	Cake	44.92	6.58	10.81	26.34	6.00	5.35	
J. W. Allison, Dallas, Texas	27431K	Seed	23.70	20.33	19.61	26.16	6.53	3.67	
		Meats	38.16	34.16	1.82	15.78	5.50	4.58	59
		Hulls	3.02	0.43	45.21	40.97	8.00	2.37	41
	27432K	Cake	49.27	7.97	6.61	24.34	6.00	5.81	
Alamo Cotton Oil Co., San Antonio, Texas	27433K	Seed	22.84	17.80	22.59	26.80	6.68	3.31	
		Meats	40.05	33.11	1.86	15.41	5.50	4.07	53
		Hulls	3.42	0.54	45.95	39.64	8.00	2.45	47
	27434K	Cake	48.31	9.60	6.36	24.21	6.00	5.52	
Russell Coleman Cotton Oil Co., San Antonio, Texas	27435K	Seed	23.35	18.94	21.28	26.35	6.60	3.48	
		Meats	39.16	33.45	1.85	15.74	5.50	4.25	56
		Hulls	3.23	0.46	45.99	39.81	8.00	2.49	44
	27436K	Cake	49.38	8.32	6.09	24.21	6.00	6.00	
Merchants and Planters Cotton Oil Co., Houston, Texas	27437K	Seed	23.05	19.04	21.28	26.42	6.60	3.61	
		Meats	38.67	33.67	1.79	15.90	5.50	4.47	56
		Hulls	3.17	0.42	46.09	39.80	8.00	2.52	44
	27438K	Cake	43.94	6.56	10.74	27.10	6.00	5.66	
Magnolia Cotton Oil Co., Houston, Texas	27439K	Seed	23.24	20.28	21.02	25.26	6.55	3.65	
		Meats	37.83	34.67	1.86	15.61	5.50	4.53	58
		Hulls	3.10	0.40	27.48	38.60	8.00	2.42	42
	27440K	Cake	43.53	8.75	9.39	26.46	6.00	5.87	
Orleans Cotton Oil Mill, New Orleans, La	27441K	Seed	24.05	20.89	19.52	25.22	6.53	3.79	
		Meats	38.37	35.00	1.78	14.66	5.50	4.69	59
		Hulls	3.45	0.59	45.06	40.42	8.00	2.48	41
	27442K	Cake	33.40	5.58	19.56	30.50	6.00	4.96	
Highland Park Mfg. Co., Rock Hill, S. C	27443K	Seed	20.41	23.39	18.37	27.44	6.50	3.89	
		Meats	32.11	38.64	1.89	17.04	5.50	4.82	60
		Hulls	2.84	0.53	43.10	43.03	8.00	2.50	40
	27444K	Cake	44.19	7.91	7.09	28.06	6.00	6.75	
Southern Cotton Oil Co., Charlotte, N. C	27445K	Seed	20.75	23.19	18.75	27.05	6.51	3.75	
		Meats	32.95	38.59	2.00	16.34	5.50	4.62	59.5
		Hulls	2.82	0.58	43.37	42.77	8.00	2.46	40.5
	27446K	Cake	39.66	6.83	12.10	29.38	6.00	6.03	
Elizabeth City Cotton Oil Co., Elizabeth City, N. C	27447K	Seed	18.36	23.11	20.71	27.43	6.58	3.81	
		Meats	30.14	40.04	1.87	17.66	5.50	4.79	57
		Hulls	2.75	0.67	45.68	40.40	8.00	2.50	43
	27448K	Cake	41.89	6.33	8.92	29.86	6.00	7.00	
Arizona Egyptian Cotton Oil Co.,* Phoenix, Arizona	27449K	Seed	19.95	23.20	19.25	26.99	6.51	4.10	
		Meats	31.25	38.57	2.07	17.44	5.50	5.17	59.5
		Hulls	3.37	0.61	44.49	41.02	8.00	2.51	40.5
	27450K	Cake	24.54	9.17	23.46	32.00	6.00	4.83	

*Whole pressed cotton seed.

Table No. 23 contains average analyses of cotton seed, and cottonseed cake, the samples being collected by G. E. Bidwell of the U. S. Department of Agriculture, for a committee of the Association of Feed Control Officials. The seed are those from which the corresponding cake was made. The analyses reported are the averages of those made in several laboratories. The cake does not represent that which could be made if all the hulls possible were eliminated, but represents that made by the mills at the time of the collection of the samples, some of it on contract for specified ammonia content.

WATER CONTENT OF TEXAS COTTONSEED MEAL.

Table No. 24 shows the distribution of the water content of Texas cottonseed meals as compiled from our analyses for three years. The total number tabulated is 1107. Of these, 10, or 0.9 per cent., contain less than 5 per cent. water, and the same number contain over 10 per cent. water. The group 7 to 8 per cent. water contains the largest number of samples. About two-thirds of the samples contain 6 to 8 per cent. water.

TABLE 24.—DISTRIBUTION OF WATER CONTENT OF TEXAS COTTONSEED MEAL.

	Less than 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	Over 10	
July 1, 1915 to Dec. 31, 1915.....	2	17	73	96	55	12	2	
Jan. 1, 1915 to July 1, 1915.....	1	14	56	68	39	5	2	
Jan. 1, 1914 to July 1, 1914.....	0	6	16	46	47	13	2	
July 1, 1914 to Jan. 1, 1915.....	3	18	76	78	27	4	1	
July 1, 1913 to Jan. 1, 1914.....	2	7	38	57	28	7	1	
Jan., 1913 to July, 1913.....	2	11	69	73	23	8	2	
Totals.....	10	73	328	418	219	49	10	1107
Per cent.....	0.9	6.6	29.6	37.8	19.8	44	0.9	

ESTIMATION OF HULLS IN COTTONSEED MEAL.

A method for the estimation of hulls in cottonseed meal may be based upon the use of a solvent which has little effect upon cottonseed hulls, but has a great effect upon cottonseed meal. A method based upon this principle was described in Bulletin No. 109 of the Texas Experiment Station.

Since the hulls are rich in crude fiber, while the meal contains only a small percentage, the quantity of hulls may also be calculated approximately from the quantity of fiber present in the meal. A method based on this fact was described by the writer in Bulletin No. 166, May, 1914, of the Texas Experiment Station. In the calculations, 5 per cent. crude fiber was assumed to be present in the pure kernel residue, and 45 per cent. crude fiber in the hulls. The figure used for the fiber in the kernel residue is too high.

A method has been published by P. S. Tilson in a paper read before the National Oil Mill Superintendents' Association, July, 1915. This method is based upon the crude fiber, the calculations being made upon the basis of water and oil-free substance in meal, meats, and in hulls. The figures used are the average of his analyses of sixteen sam-

ples of cottonseed hulls and sixteen samples of cottonseed meal prepared from reginned cotton seed, as used by the cottonseed oil mills in the manufacture of cottonseed meal. His maximum, minimum, and average percentages of crude fiber contained in the oil and water-free meats and hulls are shown in Table No. 25, the average (corrected) for crude fiber in oil and water-free hulls being 54.61 per cent.

TABLE 25.—PERCENTAGE OF CRUDE FIBER IN OIL AND WATER FREE MEAL AND HULL.

	Hull	Meal
Maximum	59.33	2.69
Minimum	51.97	2.23
Average	54.61	2.46

The method is described as follows:

"Determine the moisture, oil, and crude fiber contents of the cottonseed cake or meal sample by the usual methods. Next calculate the factors 54.39 and 2.46 to the basis of the moisture and oil contents of the sample analyzed. Then by algebraic equations the total amount of hulls in the sample of cottonseed cake or meal is obtained.

"Suppose the cottonseed cake or meal analyzed as follows:

Moisture	8.93%
Oil	7.09%
Crude Fiber	9.00%

100—(8.93+7.09)=83.98%.
54.39x83.98=45.68%.
2.46x83.98=2.07%.
Let X = amount of hulls in sample.
Let Y = amount of hull-free meal in sample.
Then X+Y=100.
45.68X+2.07Y=9.0x100.
45.68X+2.07Y=900.
2.07X+2.07Y=207.
43.61X=693.
X=15.89%. Total hulls in sample.

"NOTE.—Since this method is based on the crude fiber content of pure cottonseed hulls and hull-free meal obtained from the average reginned seed, it is evident that the method would not be as correctly applicable to cottonseed cake and meal made from cottonseed which have not been previously reginned."

This method may be reduced to the following formula:

X = Percentage of hulls in meal or cake.
W = Percentage of water in meal.
O = Percentage of oil in meal.
F = Percentage of crude fiber in meal.

$$X = \frac{100F - 2.46\ (100 - W - O)}{.5439\ (100 - W - O) - .0246\ (100 - W - O)}$$

$$X = \frac{100F - 2.46\ (100 - W - O)}{.5193\ (100 - W - O).}$$

The hulls secured by this method of calculation would contain the same percentage of oil as the meal. The excess of oil over that naturally in the hulls really belongs to the meal; so that the calculated results are to this extent too high. If the hulls are assumed to contain 0.7 per cent. ether extract (oil), the calculated percentage of hulls is to high by W—0.7 per cent. of the amount of hulls present.

Cottonseed hulls may be regarded as being composed of two things, namely, *lint,* which is the cotton fiber on the outer portion of the hull, and *hull-bran,* which is the name given to the hard woody portion of the hull by manufacturers of cottonseed oil. Some analyses of these constituents of the hull are shown in Tables Nos. 26 and 27. It will be noted that the lint is very high in crude fiber, averaging nearly 84 per cent. The hull-bran or husk contains a much smaller quantity of crude fiber, averaging 41.3 per cent. This hull-bran was prepared by delinting with acid, though one analysis of hull prepared mechanically is also given.

TABLE 26.—COMPOSITION OF DELINTED HULL.

Lab. No.		Protein	Fat	Crude Fiber	Nitrogen Free Extract	Water	Ash
10499	Delinted by acid	4.86	.85	41.46	41.23	9.05	2.55
10500	Delinted by acid	4.19	.48	40.32	43.03	9.68	2.30
10501	Delinted by acid	4.81	.57	42.29	40.76	9.03	2.54
10502	Delinted by acid	4.06	.38	41.18	38.72	13.23	2.43
10503	Delinted by acid	4.89	.60	41.33	41.60	9.05	2.53
10504	Delinted by acid	4.31	.53	41.07	43.07	8.50	2.52
	Average	4.52	.57	41.28	41.40	9.76	2.48
7988	Bare hulls (fiber pulled off)	3.33	.19	38.36	43.80	11.37	2.95

TABLE 27.—PERCENTAGE COMPOSITION OF MIDDLING COTTON.

Lab. No.		Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	Water	Ash
11111		1.63	0.46	83.66	6.40	6.53	1.32
11112		1.69	0.49	85.32	5.12	6.18	1.20
11113		1.29	0.57	83.66	7.51	5.41	1.56
11114		1.54	0.43	83.51	7.81	5.25	1.46
11115		1.50	0.34	84.01	6.88	5.75	1.52
11116		1.63	0.36	83.47	7.81	5.21	1.52
	Average	1.55	0.44	83.94	6.92	5.72	1.43

The composition of cottonseed hulls will therefore depend upon the relative quantities of lint and hull-bran present. The manufacturer keeps down the quantity of lint going into the meal as much as possible, and tries to regulate the composition of the meal with the hull-bran. This being the case, the cottonseed hulls that go into the cottonseed meal should contain a smaller proportion of lint and thus a smaller percentage of crude fiber than the hulls cut from the seed by hand. The cottonseed hulls manufactured likewise carry a larger proportion of lint and consequently a higher percentage of crude fiber than the hulls cut from the reginned seed by hand.

TABLE 28—COMPOSITION OF COTTONSEED HULLS.

Laboratory Number		Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	Water	Ash
6013	Animal Husbandary Dept. College	5.07	1.68	46.05	.....	10.97	2.50
6979	Central Texas Cotton Oil Co., Temple, 6729	5.31	1.95	50.22	.....	6.66	4.34
6980	Central Texas Cotton Oil Co., Temple, 6730	4.08	.97	52.72	.....	7.07	2.50
6981	Farmers Gin and Milling Co., 6761	4.21	.78	53.60	.....	6.87	2.48
6982	Brazos Valley care Co., Waco, 6762	4.57	1.07	53.07	.....	6.88	2.81
6983	Lagrange Cotton Oil Co	6.12	.99	53.00	.....	7.13	2.96
7701	Prof. J. C. Burns	4.71	1.26	47.03	37.28	7.19	2.53
7982	Feeding and Breeding Station	3.89	1.16	46.35	35.89	10.36	2.35
8031	Agronomy Department	3.66	.50	51.52	.....	10.52	.....
8033	Agronomy Department, see 8032	4.13	.42	49.47	.....	11.24	.....
8035	Agronomy Department, see 8034	3.83	.22	.....	.....	10.61	2.95
8039	Agronomy Department, see 8038	4.15	1.50	47.26	32.93	11.15	3.01
8041	Agronomy Department, see 8040	3.62	.42	43.15	38.36	11.63	2.22
8043	Agronomy Department, see 8042	3.21	.....	52.54	.....	10.80	2.38
8045	Agronomy Department, see 8044	3.79	.14	50.39	32.41	10.83	2.44
8049	Agronomy Department, see 8048	4.05	.26	.....	.....	.....	3.53
8051	Agronomy Department, see 8050	3.35	.46	54.61	27.61	9.94	3.71
8053	Agronomy Department, see 8052	4.69	.61	51.84	28.46	10.71	3.69
8055	Agronomy Department, see 8054	3.41	.43	53.18	29.11	11.23	2.64
8057	Agronomy Department, see 8056	3.26	.30	49.69	32.55	11.38	2.82
8059	Agronomy Department, see 8058	4.16	.49	43.42	37.62	11.26	3.05
8061	Agronomy Department, see 8060	3.64	.55	48.04	33.53	10.87	3.37
8063	Agronomy Department, see 8062	3.51	.32	53.50	28.99	10.80	2.88
8065	Agronomy Department, see 8064	3.52	.32	49.78	31.49	12.36	2.53
8067	Agronomy Department, see 8066	6.58	1.03	36.16	42.19	10.48	3.56
8069	Agronomy Department, see 8068	3.59	.32	45.49	34.96	12.31	3.33
8071	Agronomy Department, see 8070	3.25	.24	54.41	29.05	10.76	2.29
8073	Agronomy Department, see 8072	3.55	.50	44.86	35.94	12.39	2.76
8075	Agronomy Department, see 8074	4.15	.62	49.22	32.06	11.16	2.79
8077	Agronomy Department, see 8076	4.05	.60	49.02	32.50	10.15	3.68
8079	Agronomy Department, see 8078	6.31	1.34	50.04	30.27	9.10	2.94
8081	Agronomy Department, see 8080	3.96	.79	52.06	29.44	11.22	2.53
8082	Agronomy Department, see 8082	3.62	.58	52.48	30.32	10.39	2.61
8085	Agronomy Department, see 8084	3.17	.36	51.58	31.69	10.59	2.61
8087	Agronomy Department, see 8086	3.21	.32	49.55	32.85	11.32	2.75
8089	Agronomy Department, see 8088	3.70	.46	49.63	32.50	11.28	2.43
8091	Agronomy Department, see 8090	4.17	.59	50.42	31.11	11.34	2.37
8093	Agronomy Department, see 8092	3.41	.46	49.95	.....	.....	2.47
8095	Agronomy Department, see 8094	3.21	.....	46.48	.....	.....	2.59
8097	Agronomy Department, see 8096	3.89	.21	51.43	29.02	12.77	2.68
8099	Agronomy Department, see 8098	3.62	.40	49.66	31.61	12.01	2.70
8101	Agronomy Department, see 8100	3.46	.....	47.10	.....	.....	2.63
9534	Feeding Station, Coleman	5.43	1.27	44.48	36.12	10.21	2.49
9583	Feeding and Breeding Station, see 9545	4.29	1.12	45.82	35.40	10.34	3.03
9635	J. M. Jones, Coleman, Texas	4.39	1.05	46.31	36.45	9.27	2.53
9726	9688 D. E. 65, Sample 1	4.20	.57	51.82	32.69	7.88	2.84
9727	9689 D. E. 65, Sample 2	3.96	.51	51.91	32.89	7.53	3.20
9948	Feeding and Breeding Station	5.21	1.37	47.34	31.91	10.54	3.63
10990	Bryan Cotton Oil Co.	3.82	.45	44.39	38.36	10.60	2.38
	Average	4.08	.69	49.20	32.93	10.26	2.84

Table No. 28 contains hull analyses. These hulls were mostly cut by hand from seed not reginned, and so contain an excess of lint, and thus an excess of fiber.

TABLE 29.—AVERAGE COMPOSITION OF COTTONSEED KERNEL AND HULL.

	Number Averaged	Protein	Fat	Crude Fiber	Nitrogen Free Extract	Water	Ash	Crude Fiber on water and Fat Free Basis	Crude Fiber on 4% water and Fat Basis	Per Cent Kernel in Seed
Texas seed, 1913, Kernels	66	38.26	33.00	2.12	15.09	7.13	4.40	3.54	3.04	.....
Texas seed, 1914, Kernles	59	38.71	33.43	2.19	14.85	6.43	4.39	3.64	3.13	.....
Various seed (Table 23) 1914-15, Kernels	46	34.99	36.51	1.87	16.47	5.50	4.66	2.75	2.36	.....
Average of Tilson Kernels	16	.....	.....	.....	.....	.....	.....	2.46	.....	.....
Texas and other seed (committee Table 23)	14	38.54	34.24	1.81	15.65	5.50	4.26	.....	.....	58.0
Eastern seed (Committee Table 23)	32	33.38	37.50	1.87	16.92	5.50	4.83	.....	.....	58.1
Cottonseed Hulls, Texas, Bull. 166	24	4.11	1.46	45.27	37.09	9.51	2.56	50.84	43.72	.....
Various seed, 1914-15 (Committee Table 23)	46	3.12	0.54	43.69	42.15	8.00	2.50	47.78	41.09	.....
Various Hulls (Texas)	47	4.08	0.69	49.20	32.93	10.26	2.84	55.10	47.39	.....
Hull average of Tilson	16	.....	.....	.....	.....	.....	.....	54.39	.....	.....
Assumed average	.....	3.5	0.7	45.00	39.2	9.0	2.6	.....	.....	.....

*Assumed.

Table No. 29 contains the average composition of a number of samples of hulls and kernels, and also the crude fiber content calculated to an oil-and-water-free basis. According to these figures, the average percentage of crude fiber in water- and oil-free cottonseed kernels would be about 3.5 per cent. For oil- and water-free cottonseed hulls, it would be about 49 per cent. These figures are somewhat different from those secured by Mr. Tilson. They represent, however, a larger number of samples and the analyses were made in different laboratories. The figures used by Tilson are too low for the crude fiber in the kernel residue and too high for the crude fiber in the hulls. These differences compensate for one another to some extent, but in general would cause the results to be too high for meals low in crude fiber, and too low for those high in crude fiber. If we substitute the above values, the formula would become:

$$X = \frac{100F - 3.5\ (100 - W - O)}{.455\ (100 - W - O)}$$

With 9 per cent. crude fiber, we would have 15.6 per cent. hulls. These figures are still not corrected for the extra oil content of the hulls.

By the use of the analyses in Table No. 23, we may calculate the percentage of hulls in the cake from the composition of the seed from which it was made, and compare the results with the results of methods based upon the crude fiber content of the meal. Of course, the method of calculating the hull content of the meal from the seed is not strictly accurate, and this fact must be borne in mind.

CALCULATION OF HULLS FROM COMPOSITION OF CAKE AND SEED.

The results of these calculations are contained in Table No. 30.

The quantity of meal of the composition found, that could be secured from the kernels of the composition given, was calculated by the formula:

$$X = 1000\ \frac{A}{B}$$

Where X = pounds of the meal per 1000 pounds kernels.
A = percentage of protein in kernels.
B = percentage of protein in crude meal.

The quantity of pure meal that could be secured from kernels of the composition given was calculated by the formula:

$$Y = \frac{(100 - W - F)\ 1000}{100 - M - O}$$

Where Y = pounds of pure meal or kernel residue from 1000 pounds kernels.

W = water in kernels.
F = fat in kernels.
M = water in crude meal or cake.
O = fat in crude meal or cake.

In this formula, correction is made both for water and fat.

By subtracting the weight of the pure meal from the weight of the crude meal, we secure the weight of hulls. The weight of hulls divided by the weight of crude meal gives the percentage of hulls calculated from the composition of the seed. The results are in Table No. 29.

The percentage of hulls calculated by Tilson's formula are given in another column of the table. The results are usually low. This is to be expected, as the crude fiber content of the hulls used is high. On an average, the quantity of hulls found by the Tilson formula is 21.4, and that calculated from the composition of seed and meal is 23.2, a difference of 1.8 per cent. of the total, or nearly 9 per cent. of the hulls present.

TABLE 30.—QUANTITY OF PRODUCTS AND HULL CONTENT OF MEALS LISTED IN TABLE 23.

Laboratory Number	Crude Meal Pounds	Pure Meal Pounds	Hull Pounds	Per Cent Hulls	Factor	Hull by Tilson Formula	Hull by Modified Formula
18201	809	635	174	21.5	2.7	19.2	19.6
18204	867	632	235	27.1	2.6	24.6	25.8
18206	931	638	293	31.1	2.5	29.0	30.8
18208	883	622	261	29.5	2.7	25.9	27.1
18210	834	649	185	22.1	2.8	19.7	20.2
18212	930	645	285	30.0	2.6	26.2	28.1
18214	1260	649	611	48.0	2.8	40.0	43.5
18216	929	629	300	32.2	2.6	28.3	30.0
18218	857	639	218	25.4	2.6	23.0	24.0
18220	921	655	266	28.8	2.7	25.6	26.6
18222	978	659	319	32.6	3.0	25.6	27.0
18225	921	674	247	26.8	3.9	17.0	17.5
18224	801	627	174	21.7	2.0	25.3	26.5
18228	894	652	242	27.0	2.5	24.1	27.3
18230	930	662	268	28.8	2.2	31.2	33.3
18232	783	660	123	15.7	2.2	18.5	18.8
18234	852	697	155	18.1	2.0	21.9	22.7
18236	786	645	141	17.9	2.7	16.5	16.6
18238	854	667	187	21.8	2.8	19.0	19.4
18242	856	649	207	24.1	2.7	20.6	21.3
18246	814	630	184	22.6	2.5	22.0	22.8
27401	833	693	140	16.8	3.2	13.8	13.5
27403	821	688	133	16.1	2.5	16.4	16.4
27405	784	687	97	11.0	2.4	12.2	11.6
27407	797	680	117	14.6	2.4	14.9	14.8
27409	918	686	232	25.2	2.8	21.3	22.6
27411	814	684	130	15.9	2.5	16.1	16.1
27413	867	696	171	19.7	2.7	17.7	17.9
27415	1407	698	709	50.3	2.6	45.4	49.6
27417	966	689	277	28.6	2.8	24.8	26.0
27419	886	695	191	21.5	2.8	18.1	19.2
27421	898	680	218	24.2	2.7	21.6	22.4
27423	810	681	129	15.9	2.6	15.1	14.9
27425	799	698	101	12.6	3.0	11.0	10.6
27427	847	696	151	17.8	2.8	16.0	16.0
27429	840	676	164	19.5	2.5	19.0	19.4
27431	774	701	73	9.4	2.3	10.0	9.1
27433	829	751	78	9.4	2.5	9.7	8.8
27435	793	712	81	10.2	3.2	8.9	7.9
27437	880	695	185	21.0	2.7	18.9	19.3
27439	868	701	167	19.1	3.0	16.4	16.5
27441	1140	672	468	41.0	2.5	37.7	40.9
27443	726	648	78	10.7	2.6	11.1	10.3
27445	830	641	189	22.7	2.5	21.9	22.7
27447	719	621	98	12.2	2.1	14.8	14.6
27449	1310	659	651	49.6	2.4	46.3	53.0
Average	.....	.....	.....	23.2	2.6	21.4	22.2

Table No. 30 contains the percentage of hulls calculated by the modified Tilson formula, based upon 3.5 per cent. crude fiber in the oil- and water-free kernels, and 49.0 per cent. crude fiber in the hulls. In 33 of the cases, the results given by this formula are closer to the results calculated from the seed than are the results by the original Tilson formula; in 9 cases, the Tilson formula is closer, and in 4 cases the results of the two formulas are the same. The average of the results by the modified formula is 22.2, which is closer to the results secured from the analysis of the seed than the Tilson formula.

FACTORS FOR CALCULATION.

Table No. 30 also contains factors calculated by the formula:

$$S = \frac{H}{F-3}$$

Where S = the factor.
F = the crude fiber content of the meal.
H = the hull content of the meal, calculated from the seed.

Reversing the formula, we may calculate the hulls from the crude fiber:

$$H = S\ (F-3)$$

The factors found vary from 2.0 to 3.9, with an average of 2.6. The factor 3.9 is entirely too high, the probable reason being that the seed and the meal are not really related.

The formula given above is derived from the following:

$$H = \frac{F-3}{C-3}$$

Where 3 = the crude fiber content of kernels on 14 per cent. water and fat basis.

C = fiber content of hulls on 14 per cent. water and fat basis.

$$S = \frac{1}{C-3}$$

Where S is the factor.

Then the crude fiber of the hulls on an approximate 14 per cent. water and fat basis would be

$$C = \frac{1}{S} + 3$$

The average crude fiber content of the hulls in these cottonseed hulls would thus be $\frac{1}{2.6} + 3 = 38.4 + 3 = 41.4$ per cent. on the basis of the average water and fat content of these meals, which would be about 15 per cent. This is lower than the average crude fiber content of the hulls shown in Tables Nos. 28 and 29. As pointed out before,

the hulls in the meal or cake would contain less crude fiber than the commercial hulls, as they carry less lint.

Reference to Table No. 30 will show a decided variation in the factor. On account of the variation of the proportion of hull-bran to lint in different samples, the quantity of hulls calculated from the crude fiber present is more or less approximate, though sufficiently close for many purposes. For ordinary purposes, we suggest the use of the following formula for calculating the hulls from the crude fiber content:

$$H = (F—3)\ 2.46$$

Where H is the percentage of hulls, and F is the crude fiber content of the meal. When the fat and water combined vary far from 14 per cent., or when more careful calculations are desired, the formula given on page 49 should be used.

CALCULATING THE EXCESS OF HULLS IN TEXAS COTTONSEED MEAL AND HULLS.

Cottonseed meal sold in Texas must contain not less than 44 per cent. protein and not less than 51 per cent. protein and fat combined. A material containing less protein or less protein and fat contains an excess of hulls, and the quantity of excess hulls must be stated on the tag. The calculation of the excess hulls is based upon the protein, or protein and fat, and is the quantity of hulls that must be removed in order to bring the material up to standard quality.

If the material contains 7 per cent. or more of fat and less than 44 per cent. protein, then the excess hulls is the quantity that must be removed to bring the protein up to 44 per cent., allowing 3 per cent protein to be in the hulls.

$$.03H+.44\ (100—H) = P$$

The excess hulls may be calculated by subtracting the protein from 44 and dividing the result by 41.

$$H = \frac{44—P}{41}$$

where P = the protein in the meal and hulls.
H = the hulls.

If the material contains less than 7 per cent. fat, it must contain sufficient protein to make the total of protein and fat 51 per cent., in order to be termed cottonseed meal. The removal of hulls will, however, increase the fat in proportion to the quantity removed. If the calculations are made on the basis given above, the quantities of fat that will be raised to 7 per cent. fat are given in Table No. 31.

TABLE 31.—RELATION OF PROTEIN TO FAT AND HULL CONTENT OF TEXAS MEAL

Protein Per Cent	Corresponding Per Cent Hulls excess	Fat will be Raised to 7%
43	2.4	6.84
42	4.9	6.65
41	7.3	6.49
40	9.7	6.32
39	12.2	6.15
38	14.6	6.01
37	17.1	5.87
36	19.5	5.69

If the fat associated with the protein is equal or more than that in the table, the excess hulls is calculated by the formula:

$$H = \frac{44 - P}{44}$$

If the fat associated with the protein is less than that given, then the excess hulls is calculated by the formula:

$$H = \frac{44 + (R - F) - P}{44 + (R - F)}$$

Where H is the excess of hulls.

R = the fat from Table No. 31 corresponding to the protein in the meal and hulls.

P = the protein in the meal and hulls.

F = the fat content of the meal and hulls.

COMPOSITION OF COTTON SEED.

The composition of the cotton seed affects the yield of oil, lint, meal, and hulls secured from it. The quantity of lint depends, to some extent, upon the method of ginning, although some varieties of seed retain much less lint than others. The important constituent of the seed is the oil; the more oil it contains, the more valuable it is to the miller. There is often greater competition between the mills in purchasing seed in localities whose seed is rich in oil than there is in localities producing poor seed; and the price paid for the better seed may be higher than that paid for poor seed. A difference of 1 per cent. oil represents 2.7 gallons of oil per ton, which at 40 cents per gallon would be $1.08 per ton. Seed may, however, vary much more than 1 per cent. in oil content, as may be seen from the analyses given. This matter will be discussed further on a subsequent page.

CALCULATING THE YIELDS FROM THE ANALYSIS OF THE SEED.

Although, as stated elsewhere, there is a relation between the composition of the seed and the composition of the meal produced from it, yet on account of the standardization of cottonseed meal, the composition of the seed is usually looked at from the standpoint of the number of gallons of oil and the number of pounds of meal of a certain grade that can be produced from it. Thus, in Georgia, the miller who is trying to make meal containing 7½ per cent. ammonia takes out a larger quantity of hulls when the seed is low in ammonia and permits a larger quantity of hulls to go in when the seed is high in ammonia. Thus, the composition of the seed regulates as nearly as possible the quantity of meal made. The quality of the product is regulated by the quantity of meal produced, the machinery being adjusted to produce the quantity desired, according to the character of the seed, and is controlled by a chemical analysis of the product and also of the seed. In the larger mills these analyses are made daily.

It has been stated that, if proper care is exercised in the laboratory,

the test of seed should represent at the outside within one gallon of what the yield of oil should be and within 50 pounds of the yield of meal.

A method used in calculating the results is given in the September, 1914, issue of The Oil Miller, by Mr. F. B. Porter, President of the Fort Worth Laboratories, as follows:

"In reporting analysis of seed, it is customary to report the results on the basis of clean seed with lint still on; i. e.—the per cent. of hulls also includes the linters. The following formulae have been derived, assuming that hulls as made in the mill contain .3 per cent. ammonia, and that hulls naturally contain .2 per cent. of gasoline soluble extractives. For the sake of those persons interested in following the derivation of the formulae, the original form of each formula is given. The original form is followed by the simplified form where necessary, which can be used by anyone knowing addition, multiplication, and subtraction:

a = per cent. of meats in seed.
b = per cent. of oil in meats.
c = per cent. of hulls in seed.
d = pounds of lint cut per ton of seed.
e = 1 minus average per cent. of oil in cake.
f = weight of hulls per ton of seed.
g = weight of cake per ton of seed.
h = per cent. of ammonia in seed.
i = weight of hulls in cake per ton of seed.
j = 1 minus average per cent. of oil in hulls as made.
k = per cent. of ammonia desired in cake.
l = weight of oil per ton of seed.
m = average per cent. of oil in cake.
n = average per cent. of oil in hulls as made, less 0.2 per cent.

I. Weight of cake per ton of seed... $g = \frac{2000h-(2000c-d).003}{k}$

Simplified ..... $g = \frac{2000h-6c+.003d}{k}$

II. Weight of hulls in cake per ton of seed. $i = g-\frac{2000a-2000ab}{e}$

Simplified ..... $i = ge-2000a+2000ab$

Weight of hulls per ton of seed..... $f = \frac{2000c-i-d}{j+.002}$

Weight of oil per ton of seed..... $l = 2000ab-mg-nf$

$g+d+f+l = 2000$

In case the ammonia is given as a certain per cent. of the meats, instead of as a per cent. of the seed, the formula for g (weight of cake per ton of seed) becomes:

$$g = \frac{2000ap}{k}$$

where p is the per cent. of ammonia in meats.

"In the above calculations no account has been taken of the gain or loss in cooking. During a season like last season with excessive moisture in seed, there is undoubtedly a loss of weight during cooking. When the seed is dry and considerable water is added, there is probably a gain. This factor is not capable of exact expression, and is therefore thrown in with the so-called invisible losses of the mill.

"The invisible loss of a mill is made up of the loss in operation, loss due to dirt and motes, and loss or gain due to cooking. In order to obtain what weight of products the seed will actually give, taking into consideration the invisible loss, it is necessary to multiply the weights of products obtained in the above calculations by (2000—O—d) divided by (2000—d)." O = average invisible loss.

The loss in moisture content could be allowed for by basing the calculations upon the oil- and moisture-free substance or by calculating the oil and moisture content by a method similar to that of Tilson, page 45, used in calculating the percentage of hulls in cottonseed meal from the crude fiber. A method of this kind is used on page 49.

The above method is not exactly followed by all commercial chemists, the difference being in the amount of ammonia and oil assumed to be in the hulls. The analysis of the seed for oil is based almost entirely upon the analysis of the kernels. The ammonia is sometimes determined in the kernels, but usually in the entire seed. In either case, an assumed value for the hulls is used in calculating the results.

The method of calculating the quantity of hulls described above is not exactly correct, since they are assumed to contain the same quantity of oil as the meal, whereas the hulls contain much less. This excess of oil really belongs with the kernel residue. Correction can be made by multiplying the weight of hulls by the per cent. of oil in the meal and by subtracting the result from the quantity of hulls found by the first calculation. There is also no allowance for the protein content of the hulls. With a protein content of 3 per cent., 200 pounds of hulls per 1000 pounds meal would represent 0.6 per cent. excess protein. On a basis of 40 per cent. protein, this would represent 15 pounds more meal per 1000 pounds. This quantity is within the limits of manufacturing possibility; so that the error is not great. The oil in the hulls, and the protein in the hulls are errors that balance one another as a rule in manufacturing.

EFFECT OF CONDITIONS ON COMPOSITION OF SEED.

A number of seed analyses are given by Garner, Allard, and Foubert in the Journal of Agricultural Research, 1914, page 228. According to the work reported by them, cited below, the oil content of cottonseed may be affected by the degree of maturity of the seed, the variety, and the soil and fertilizer used.

Mature and Immature Seed.—Table No. 32 shows the difference between the oil content of mature and immature seed selected in South Carolina. The average difference in favor of the mature seed is 2 per cent. oil, or 5.7 gallons per ton of seed.

TABLE 32.—OIL OF MATURE AND IMMATURE SEED, GARNER, ET AL.

	Per Cent Meats	Per Cent Oil in Seed
Immature Seed		
Toole	55.4	20.9
Trice	54.4	18.8
McCall	59.6	21.4
Average	56.5	20.4
Mature Seed		
Toole	61.2	23.3
Trice	57.6	20.9
McCall	60.7	22.9
Average	59.8	22.4

Soil and Fertilizer.—Table No. 33 shows the difference between the oil content as affected by soil and fertilizer. There is practically no difference in the oil content of kernels grown on two varieties of Georgia soil, though there is a small difference in the percentages of kernels.

TABLE 33.—SOIL AND FERTILIZER AFFECTING COTTONSEED. GARNER, ET AL.

	Per Cent Meats	Per Cent Oil in Meats	Per Cent Oil in Seed
Red Georgia Soil—1909	58.7	37.69	.....
1910	59.7	36.67	.....
1911	59.2	37.41	.....
Average	59.2	37.28	22.07
Gray Georgia Soil—1909	58.3	36.46	.....
1910	58.8	38.53	.....
1911	58.6	37.33	.....
Average	58.6	37.44	21.94
No Fertilizer	52.9	33.56	.....
	53.2	32.99	.....
	52.7	34.38	.....
	52.4	33.49	.....
Average	52.8	33.61	17.75
Complete Fertilizer—9-3-2	55.1	37.48	.....
9-6-2	55.0	33.85	.....
9-3-4	55.7	38.07	.....
9-6-4	56.1	36.40	.....
9-3-6	54.2	38.86	.....
9-6-6	56.0	36.78	.....
15-6-3	56.8	38.60	.....
15-3-4	55.3	37.48	.....
15-6-4	56.4	36.85	.....
Average	55.6	37.15	20.66

The fertilizer caused a decided increase in the oil content of the kernels, the average increase being 2.91 per cent. of the seed of 7.7 gallons of oil per ton of seed. The seed grown on the poor South Carolina soil is very low in oil for that locality.

TABLE 34.—VARIETY OF SEED—AVERAGE 1909-1910-1911. GARNER, ET AL.

	Per Cent Meats	Per Cent Oil in Meats	Per Cent Oil in Seed
Northern Georgia.			
King	59.5	36.54	.....
Runnell	57.5	37.40	.....
Shine	58.7	37.52	.....
Toole	60.3	37.33	.....
Dixie	59.4	38.06	.....
Hawkin	57.8	36.72	.....
Average	58.9	37.26	21.85
South Carolina Central Plain.			
King	58.2	39.14	.....
Runnell	55.7	40.73	.....
Shine	55.9	41.23	.....
Toole	57.9	40.87	.....
Dixie	57.3	42.07	.....
Hawkin	53.6	40.83	.....
Average	56.4	40.81	23.02

Locality.—Table No. 33 and also Table No. 34 show some effects of locality on the composition of the seed. The seed grown in Northern Georgia are poorer in oil than those grown in the South Carolina coastal plain, presumably with fertilizer, the difference being 1.17 per cent., or 34 gallons of oil per ton.

Varieties.—Table No. 34 shows some effect of varieties upon the composition of the seed, though the locality approximately has a greater effect. Table No. 35 from C. B. William's August, 1906, Bulletin of the North Carolina Board of Agriculture, shows great variations due to varieties. The seed were all grown on the Edgecombe North Carolina test farm.

TABLE 35.—COMPOSITION OF NORTH CAROLINA COTTONSEED (WILLIAMS, 1904).

	Per Cent Meat	Per Cent in Meat	Per Cent Nitrogen in Meat
Average of 25 varieties	57.40	39.66	4.86
Maximum in oil (Peterkin)	56.73	42.02	4.64
Minimum in oil (Excelsior Ralifre)	54.94	37.26	5.06
Maximum in Nitrogen (Toole)	61.35	39.84	5.76
Minimum in Nitrogen (Hodge)	56.10	41.90	4.37

EASTERN AND WESTERN SEED.

Seeds from the Eastern States contain more oil and less protein than those from the Western States. Table No. 36 contains average analyses as reported by several commercial chemists. A difference of nearly 3 per cent. oil, or 8 gallons per ton of seed, is shown between average seed analyzed in Atlanta and in Fort Worth or Houston. The figures given are the averages for the seasons indicated.

TABLE 36.—ANALYSIS OF SEED BY COMMERCIAL CHEMISTS.

	Moisture Per Cent	Oil, Per Cent	Available Oil Per Ton, Gal.	Total Oil Per Ton, Gal.	Ammonia Per Cent	Meats, Per Cent	Cake 7 1-2% Ammonia(lbs.)	Cake 45% Protein (lbs.)
Picard-Law, Atlanta, Ga., 1912-13	10.44	19.90	43.9	53.1	3.38	54.8	856	.....
Picard-Law, Atlanta, Ga., 1913-14	10.37	20.40	45.2	54.4	3.45	55.0	874	.....
Picard-Law, Atlanta, Ga., 1914-15	10.00	20.20	44.7	.....	3.49	.....	884	.....
Houston Laboratory, Houston, Tex. 1914-15	10.23	17.29	35.2	46.2	4.24	53.8	.....	.....
Houston Laboratory, Houston, Tex. 1915-16	9.08	18.04	38.1	.....	4.12	53.3	.....	894
Fort Worth Laboratory, Fort Worth, Tex., 1913-14	.....	16.71	.....	44.6	.....	53.9	.....	.....
Fort Worth Laboratory, Fort Worth, Tex., 1914-15	9.48	16.91	.....	45.1	4.24	55.8	.....	970
Fort Worth Laboratory, Fort Worth, Tex., 1915-16	10.05	18.12	.....	48.3	.....	54.2	.....	.....

COMPOSITION OF PURE KERNEL RESIDUE.

Table No. 45 shows the average composition of the pure kernel residue, free from hulls, that would be secured if the water and fat content should be reduced to 15 per cent.

On an average there is 5 per cent. difference in the protein content of the residue of Eastern and Western seed.

COMPOSITION OF TEXAS COTTON SEED.

A study of the composition of Texas cotton seed was made for two years, the samples used being from varieties grown in the various substations, and kindly furnished by Mr. H. Jobson, Assistant Agronomist. The objects of the study were to ascertain the relation of variety, and soil or season conditions to the composition of the seed, as well as to secure information as to Texas seed.

The seed were ginned in a hand gin. In some cases, this left more lint upon the seed than the ordinary ginning process. For this reason, in the second year of the experiment, we devised and used a method for lint on the seed, which is described on another page. The excess of lint would, of course, affect the relative proportion of hull to meats.

Table No. 37 shows the composition of the cottonseed kernels for the two years, arranged by localities.

TABLE 37.—COMPOSITION OF COTTONSEED KERNELS ARRANGED BY LOCATION.

Laboratory Number		Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent Kernels	Per Cent Lint
	From College Station, 1913.								
8088	Unknown, L. S.	41.71	28.57	.....	.....	10.27	.....	50.8	.....
8090	Lone Star.	35.23	30.13	2.12	.....	9.15	.....	50.1	.....
8092	Mebane Triumph	40.04	29.09	1.69	.....	9.09	.....	53.4	.....
8094	Black Rattler.	39.95	30.54	.....	.....	9.42	.....	57.9	.....
8096	Hendricks.	38.18	29.07	.....	.....	9.19	.....	54.8	.....
8098	Bank Account	40.69	30.05	1.94	.....	9.11	.....	54.4	.....
8100	Cleveland Big Boll	42.34	28.85	2.32	.....	8.77	.....	53.2	.....
8102	Mortgage Lifter	42.36	28.98	2.15	.....	6.52	.....	51.4	.....
8104	Rowden.	41.75	30.05	1.89	.....	7.26	.....	54.6	.....
8106	Half and Half	41.90	29.90	.....	.....	8.86	.....	54.5	.....
	Average	40.42	29.56	2.02	.....	8.76	.....	53.5	.....
	From College Station, 1914.								
9316	Bank Account	41.16	31.24	2.18	14.65	6.38	4.39	51.2	10.4
9317	Half and Half	40.58	31.54	.....	.....	5.98	.....	51.8	10.9
9318	Cleveland Big Boll	41.95	30.59	.....	.....	5.95	.....	49.8	14.5
9319	Mortgage Lifter	43.44	29.21	.....	.....	6.16	.....	50.0	13.7
9320	Lone Star.	40.63	31.28	.....	.....	6.40	.....	52.0	12.2
9321	Black Rattler.	38.47	33.26	.....	.....	6.34	.....	58.4	7.1
9322	Mebane.	41.07	31.60	.....	.....	6.26	.....	52.4	12.4
9323	Crowder	39.20	32.94	.....	.....	6.23	.....	54.4	15.1
9324	Hendricks.	39.97	32.36	.....	.....	5.97	.....	54.4	.....
9325	Rowden.	39.22	32.84	2.18	15.72	5.83	4.21	54.8	13.7
	Average	40.56	31.68	2.18	15.13	6.15	4.30	52.92	12.2
	From Lubbock, 1913.								
8145	Lone Star, No. 11.	36.90	33.03	.....	.....	6.70	.....	54.2	.....
8146	Crowder, No. 16.	37.95	35.28	1.78	.....	6.62	.....	55 8	.....
8147	Mortgage Lifter, No. 152.	36.16	35.93	1.96	.....	5.66	.....	54.5	.....
8148	Half and Half, No. 443.	36.15	35.53	1.94	.....	6.01	.....	54.7	.....
8149	Bank Account, No. 130.	36.34	35.57	2.47	.....	5.46	.....	56.2	.....
8150	Rowden, No. 77.	35.61	35.51	1.73	.....	5.55	.....	55.6	.....
8151	Bank Account, No. 130.	38.25	33.25	2.25	.....	6.59	.....	54.8	.....
8152	Black Rattler, No. 348.	35.20	36.88	1.99	.....	5.40	.....	58.8	.....
8153	Mortgage Lifter, No. 152.	38.95	33.17	.....	.....	6.98	.....	53.7	.....
8154	Cleveland Big Boll, No. 485.	38.26	33.83	2.31	.....	6.64	.....	52.6	.....
8155	Mebane Triumph, No. 128.	38.20	34.22	1.95	.....	6.41	.....	55.4	.....
	Average	37.00	34.75	2.04	.....	6.18	.....	55.1	.....
	From Lubbock, 1914.								
9782	Bank Account	35.22	35.20	.....	.....	5.74	.....	56.1	10.7
9783	Black Rattler.	35.18	35.91	.....	.....	5.74	.....	60.5	7.7
9784	Cleveland Big Boll	37.96	34.55	.....	.....	6.14	.....	52.2	15.4
9785	Crowder	36.51	34.88	.....	.....	5.81	.....	56.1	14.6
9786	Half and Half	36.56	33.75	.....	.....	5.57	.....	56.1	10.7
9787	Hendricks.	37.29	34.53	.....	.....	6.97	.....	56.0	6.0
9788	Lone Star.	37.01	33.75	.....	.....	6.47	.....	54.0	12.7
9789	Mebane Triumph	37.17	34.23	.....	.....	6.55	.....	54.5	12.1
9790	Mortgage Lifter	34.21	35.88	.....	.....	6.52	.....	52.0	12.1
9791	Rowden.	36.34	34.58	.....	.....	6.79	.....	56.2	14.2
	Average	36.34	34.72	.....	.....	6.22	.....	5.53	11.6
	From Pecos, 1913.								
8138	Cleveland Big Boll	32.59	38.03	.....	.....	5.85	.....	53.2	.....
8139	Mebane Triumph	36.22	36.37	.....	.....	.....	.....	55.4	.....
8140	Lone Star.	35.85	35.57	.....	.....	5.52	.....	56.0	.....
8141	Black Rattler.	33.57	38.58	.....	.....	5.49	.....	61.2	.....
8142	Rowden.	32.69	37.95	2.80	.....	5.86	.....	55.3	.....
8143	Crowder.	32.64	39.01	.....	.....	5.66	.....	55.3	.....
8144	Half and Half	34.87	36.03	2.13	.....	5.95	.....	55.9	.....
	Average	34.06	37.36	2.47	.....	5.72	.....	56.0	.....

TABLE 37.—COMPOSITION OF COTTONSEED KERNELS ARRANGED BY LOCATION —Continued.

Laboratory Number		Protein	Ether extract	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent Kernels	Per Cent Lint
	From Pecos, 1914.								
9361	Rowden	33.54	36.49	2.25	17.15	5.66	4.91	53.4	18.6
9362	Hendricks	40.85	31.36	2.27	14.73	6.26	4.53	56.4	6.9
9363	Half and Half	36.31	34.02	4.15	14.88	5.84	4.80	53.8	10.5
9364	Crowder	39.92	33.38	2.29	14.50	5.42	4.49	53.6	13.2
9365	Lone Star	39.81	32.06	2.50	15.12	5.68	4.83	50.2	13.9
9366	Mebane	37.54	33.26	2.10	17.00	5.42	4.68	52.2	7.7
9367	Black Rattler	35.32	34.55	2.74	17.41	5.58	4.40	59.0	7.7
9368	Cleveland Big Boll	41.06	31.77	1.99	13.84	6.40	4.94	51.2	.....
9369	Mortgage Lifter	35.06	35.61	2.03	16.10	6.22	4.98	50.8	15.2
9370	Bank Account	31.90	37.01	2.13	16.48	7.41	5.07	54.8	13.3
	Average	37.13	34.00	2.44	15.69	5.98	4.76	53.5	11.8
	From Beeville, 1914.								
9398	Bank Account	42.87	29.88	2.16	13.24	8.05	3.80	48.4	15.8
9399	Black Rattler	37.81	32.53	2.10	17.47	6.49	3.60	54.4	11.3
9400	Cleveland Big Boll	41.95	31.84	1.93	15.19	5.16	3.93	50.2	12.3
9401	Crowder	39.44	32.88	1.98	16.02	6.17	3.51	50.6	16.1
9402	Half and Half	38.42	31.78	2.15	17.48	6.46	3.71	52.0	16.6
9403	Hendricks	38.56	32.66	1.87	16.76	6.42	3.73	54.7	12.0
9404	Lone Star	41.21	30.94	1.85	15.61	6.80	3.59	49.5	15.2
9405	Mebane	39.51	33.23	2.05	15.28	6.41	3.52	51.0	.....
9406	Mortgage Lifter	41.73	31.82	2.11	13.52	7.12	3.70	51.4	13.3
9407	Rowden	37.23	32.73	1.84	16.86	7.57	3.77	52.5	10.7
	Average	39.87	32.02	2.00	15.77	6.66	3.68	51.4	13.7
	From Nacogdoches Station, 1913.								
8050	Crowder, No. 16	34.72	36.44	2.04	.....	6.90	.....	52.5	.....
8052	Mebane Triumph, No. 12	37.01	34.53	1.94	.....	6.71	.....	53.0	.....
8054	Rowden, No. 77	35.22	37.06	1.92	.....	6.53	.....	53.5	.....
8056	Lone Star, No. 11	37.41	34.06	.....	.....	7.64	.....	55.0	.....
8058	Black Rattler, No. 348	34.97	36.49	2.10	.....	7.11	.....	55.0	.....
8060	Bank Account, No. 130	36.65	33.89	2.03	.....	7.63	.....	52.5	.....
8062	Cleveland Big Boll, No. 485	40.23	32.01	2.36	.....	7.79	.....	51.0	.....
8080	Half and Half, No. 443	35.97	34.75	1.97	.....	7.33	.....	53.5	.....
8082	Mortgage Lifter, No. 152	38.67	33.14	3.24	.....	7.60	.....	52.5	.....
	Average	36.76	34.71	2.20	.....	7.25	.....	53.2	.....
	From Nacogdoches, 1914.								
9443	348—Black Rattler	37.02	34.82	2.13	15.69	6.20	4.14	60.9	7.6
9444	130—Bank Account	36.63	35.05	1.86	16.15	6.06	4.25	54.9	12.5
9445	485—Cleveland	37.81	33.17	2.22	16.41	6.18	4.21	52.8	13.8
9446	16—Crowder	36.07	35.56	1.64	16.43	6.05	4.25	55.5	14.4
9447	443—Half and Half	39.53	33.55	2.30	14.38	5.99	4.25	56.9	10.8
9448	70—Hendricks	39.06	33.61	1.61	15.36	6.11	4.25	58.2	9.1
9449	11—Lone Star	39.95	33.95	1.82	14.58	5.37	4.33	54.4	12.9
9450	128—Mebane	37.73	34.10	1.30	17.14	5.55	4.18	54.6	12.8
9451	152—Mortgage Lifter	38.08	34.04	2.20	14.61	6.60	4.47	55.8	16.0
9452	77—Rowden	36.90	34.35	1.74	16.05	6.37	4.59	55.0	17.1
	Average	37.87	34.22	1.88	15.70	6.04	4.29	55.9	12.7
	From Spur, 1914.								
9453	130—Bank Account	39.06	35.09	2.02	13.83	5.58	4.42	57.4	9.3
9454	3534—Black Rattler	37.44	35.59	1.71	15.68	5.36	4.22	59.7	8.6
9455	485—B. B. Cleveland	39.64	33.05	2.02	13.34	7.63	4.32	50.5	14.9
9456	16—Crowder	38.09	34.66	1.97	14.69	6.24	4.35	55.7	14.9
9457	443—Half and Half	37.63	34.55	2.02	14.69	6.71	4.40	52.0	11.6
9458	79—Hendricks	38.28	32.86	2.61	14.74	7.15	4.36	58.6	7.1
9459	11—Lone Star	38.25	32.51	2.10	17.88	5.00	4.26	53.2	11.3
9460	128—Mebane	38.35	33.35	2.71	13.41	8.01	4.17	55.4	10.8
9461	152—Mortgage Lifter	38.48	33.18	2.87	13.45	7.64	4.38	54.8	11.9
9462	77Rowden	36.80	34.03	2.45	14.64	7.50	4.58	55.7	14.4
	Average	38.20	33.89	2.24	14.64	6.69	4.34	55.3	11.4

TABLE 37.—COMPOSITION OF COTTONSEED KERNELS ARRANGED BY LOCATION —Continued.

Laboratory Number		Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent Kernals	Per Cent Lint
	From Angleton, 1914.								
9463	Bank Account	40.58	33.77	2.23	12.01	7.03	4.38	53.9	12.4
9464	Black Rattler	39.00	34.36	2.46	12.75	7.32	4.11	57.5	9.8
9465	Cleveland B. B	41.88	32.13	2.45	10.58	8.39	4.57	50.0	15.8
9466	Crowder	41.35	32.93	2.40	11.39	7.60	4.33	53.5	13.8
9467	Half and Half	39.83	33.72	2.56	12.32	7.13	4.44	54.5	12.8
9468	Hendricks	40.00	33.66	2.45	13.88	5.61	4.40	55.6	10.0
9469	Lone Star	41.48	32.69	2.21	12.49	6.83	4.30	53.6	10.8
9470	Mortgage Lifter	39.63	33.33	2.38	13.02	7.18	4.46	51.6	10.7
9471	Rowden	41.38	32.60	2.09	11.78	7.78	4.37	52.4	14.0
	Average	40.58	33.25	2.35	12.25	7.20	4.37	53.6	12.2
	From Troup, 1913.								
8006	Cleveland Big Boll, No. 485	41.30	29.69	2.47	.....	8.41	.....	49.4	.....
8032	Lone Star, No. 11	38.97	30.53	.....	.....	8.27	.....	49.3	.....
8034	Hendricks, No. 79	40.59	31.61	2.34	.....	8.40	.....	54.6	.....
8036	Mebane Triumph, No. 128	41.36	31.08	2.39	.....	8.54	.....	51.8	.....
8038	Half and Half, No. 443	41.20	30.94	1.95	.....	7.79	.....	54.0	.....
8040	Black Rattler, No. 348	38.25	32.26	2.28	.....	7.73	.....	56.8	.....
8042	Crowder, No. 16	38.56	31.14	1.98	.....	7.66	.....	55.0	.....
8044	Mortgage Lifter, No. 152	41.72	29.63	1.98	.....	7.78	.....	52.2	.....
8046	Rowden, No. 77	40.76	31.55	1.77	.....	7.62	.....	54.0	.....
8048	Bank Account, No. 150	40.41	31.61	2.23	.....	7.58	.....	55.0	.....
	Average	40.31	31.00	2.15	.....	7.98	.....	53.2	.....
	From Troup, 1914.								
9716	Bank Account	37.37	34.60	1.86	15.44	5.90	4.83	56.7	9.0
9717	Black Rattler	37.95	33.75	1.95	15.41	5.97	4.97	61.6	.....
9718	Cleveland Big Boll	37.84	33.44	2.09	16.12	5.33	5.18	52.7	13.7
9719	Crowder	37.37	35.39	2.08	14.11	6.14	4.91	55.8	14.6
9720	Half and Half	35.98	33.42	3.10	16.97	5.86	4.67	56.0	10.9
9721	Hendricks	40.40	31.43	2.43	14.06	6.99	4.69	58.8	5.7
9722	Lone Star	39.50	33.00	2.23	14.45	6.08	4.74	55.9	9.8
9723	Mebane	39.57	32.06	2.45	14.41	6.70	4.81	55.2	10.9
9724	Mortgage Lifter	41.20	32.41	2.30	13.28	5.78	5.03	53.6	12.9
9725	Rowden	40.80	32.71	1.61	13.61	6.10	5.17	56.3	16.2
	Average	38.79	33.23	2.21	14.78	6.09	4.90	56.2	11.5
	From Denton Station, 1913.								
8064	Lone Star, No. 11	39.69	30.73	.....	.....	8.61	.....	53.5	.....
8066	Hendricks, No. 78	39.86	30.48	2.38	.....	8.63	.....	55.0	.....
8068	Bank Account, No. 130	40.06	32.39	1.96	.....	6.89	.....	54.8	.....
8070	Crowder, No. 16	39.61	32.75	1.87	.....	8.30	.....	54.7	.....
8072	Black Snake, No. 348	37.98	33.37	2.07	.....	8.53	.....	58.4	.....
8074	Half and Half, No. 443	40.16	31.87	2.22	.....	8.33	.....	54.6	.....
8076	Mortgage Lifter, No. 152	41.01	30.96	.....	.....	7.98	.....	52.5	.....
8078	Rowden, No. 77	35.84	32.50	.....	.....	8.77	.....	54.7	.....
8084	Mebane Triumph, No. 128	39.86	31.20	.....	.....	6.55	.....	53.4	.....
8086	Cleveland Big Boll, No. 485	40.42	30.63	2.32	.....	7.54	.....	51.9	.....
	Average	39.45	31.69	2.14	.....	7.18	.....	54.4	.....
	From Temple, 1913.								
8320	Millers Long Staple	39.87	32.29	.....	.....	6.46	.....	53.4	.....
8321	Hogins Long Staple	37.75	34.73	1.89	.....	6.22	.....	54.9	.....
8322	Cleveland Big Boll, No. 485	39.37	32.86	.....	.....	6.85	.....	51.5	.....
8323	Bank Account, No. 130	38.49	34.48	.....	.....	6.21	.....	54.0	.....
8324	L. S., No. 178	38.49	32.33	1.93	.....	5.75	.....	55.2	.....
8325	Black Rattler	37.33	33.94	.....	.....	6.13	.....	56.2	.....
8326	Crowder, No. 16	37.63	33.81	.....	.....	6.04	.....	53.6	.....
8327	Mortgage Lifter, No. 152	40.13	32.29	.....	.....	6.52	.....	53.3	.....
8328	Lone Star, No. 11	37.95	32.46	.....	.....	6.61	.....	52.0	.....
	Average	38.56	33.24	1.91	.....	6.31	.....	53.8	.....

Table No. 38 shows the average composition of the cottonseed kernels, arranged by localities for the two years. From seven to ten varieties were taken from each locality, and as nearly as possible the same varieties were secured from each station, but this was not always possible.

TABLE 38.—AVERAGE COMPOSITION OF COTTONSEED KERNELS FROM VARIOUS LOCALITIES.

	No. Averaged.	Protein	Ether extract	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent Kernels	Per Cent Lint
College Station	10	40.42	29.56	2.02	.....	8.76	.....	53.5	.....
College Station, 1914	10	40.56	31.68	2.18	15.13	6.15	4.30	52.9	12.2
Lubbock, 1913	11	37.00	34.75	2.04	.....	6.18	.....	55.1	.....
Lubbock, 1914	10	36.34	34.72	2.47	.....	6.22	.....	55.4	11.6
Pecos, 1913	7	34.06	37.36	2.44	.....	5.72	.....	56.0	.....
Pecos, 1914	10	37.13	34.00	2.00	15.69	5.98	4.76	53.5	11.8
Beeville, 1914	10	39.87	32.02	2.20	15.79	6.66	3.68	51.4	13.7
Nacogdoches, 1913	9	36.76	34.71	1.88	.....	7.25	.....	53.2	.....
Nacogdoches, 1914	10	37.87	34.22	2.24	15.70	6.04	4.29	55.9	12.7
Spur, 1914	10	38.20	33.89	2.35	14.64	6.69	4.34	55.3	11.4
Angleton, 1914	10	40.58	33.25	2.15	12.25	7.20	4.37	53.6	12.2
Troup, 1913	10	40.31	31.00	2.21	.....	7.98	.....	53.2	.....
Troup, 1914	10	38.79	33.23	2.14	14.78	6.09	4.90	56.2	11.6
Denton, 1913	10	39.45	31.69	.....	.....	7.18	.....	54.4	.....
Temple, 1913	9	38.56	33.24	1.91	.....	6.31	.....	53.8	.....

The highest fat content is shown at Pecos, in the western part of the State, in 1913. The lowest is at College Station, in 1913. College Station, Beeville, Troup, and Denton show a smaller fat content; Nacogdoches, Lubbock, Pecos, Spur, Angleton, and Temple show a larger fat content. Nacogdoches is in the eastern part of the State; while Lubbock, Pecos, and Spur are in the western part. The differences here shown are thus not altogether due to climatic conditions, but are partly due to the soil.

TABLE 39.—AVERAGE COMPOSITION OF SEED AND YIELD BY LOCALITIES.

	Percentage		Meal Lbs. Per Ton	Oil Gallons Available Per Ton
	Protein	Fat		
College Station, 1913-14	21.54	15.97	979	33.3
Lubbock, 1913-14	20.28	19.21	922	42.5
Pecos, 1913-14	19.51	19.55	887	43.9
Beeville, 1913-14	20.49	16.46	932	35.2
Nacogdoches, 1913-14	20.38	18.82	926	41.5
Spur, 1914	21.12	18.74	960	41.1
Angleton, 1914	21.75	17.82	989	38.3
Troup, 1913-14	21.63	17.56	984	37.6
Denton, 1913	21.46	17.24	976	36.9
Temple, 1913	20.75	17.88	943	38.9

Table No. 39 shows the average composition of the seed and yields by localities, 7 to 10 varieties from each locality being grown two years. The yield of meal is based upon 44 per cent. protein, and the yield of oil upon 7 per cent. oil in the meal, with no manufacturing loss. The yields are seen to vary from 33.3 to 41.5 gallons oil per ton, and the

yield of meal from 887 to 989 pounds per ton. The lowest yield of oil is at College Station, and the highest at Pecos; where the cotton was grown under irrigation. The writer is inclined to believe that the differences are due largely to the soil, and to a less extent to seasonal conditions.

TABLE 40.—AVERAGE COMPOSITION OF COTTONSEED KERNELS OF VARIOUS VARIETIES.

	No. Average.	Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent Kernels	Per Cent Lint
Bank Account, 1913	7	38.56	33.05	2.15	.....	7.07	.....	54.5	.....
Bank Account, 1914	9	38.10	33.98	2.06	14.70	6.60	4.56	54.3	11.7
Black Rattler, 1913	7	36.75	34.58	2.11	.....	7.12	.....	57.8	.....
Black Rattler, 1914	8	37.27	34.35	2.18	15.79	6.17	4.24	59.1	8.5
Cleveland Big Boll, 1913	7	39.22	32.27	1.89	.....	6.33	.....	51.8	.....
Cleveland Big Boll, 1914	8	40.01	32.57	2.12	14.31	6.43	4.56	51.2	14.3
Crowder, 1913	6	36.85	34.74	1.92	.....	6.86	.....	54.5	.....
Crowder, 1914	8	38.49	34.08	2.06	14.69	6.28	4.37	54.4	14.6
Half and Half, 1913	6	38.38	33.17	2.04	.....	7.38	.....	54.5	.....
Half and Half, 1914	8	38.11	33.29	2.71	15.32	6.19	4.38	54.1	11.9
Hendrick, 1913	3	39.54	30.39	2.36	.....	8.74	.....	54.8	.....
Hendrick, 1914	8	39.30	32.81	2.21	14.92	6.43	4.33	56.6	7.1
Hogins Long Staple, 1913	1	37.75	34.73	1.89	.....	6.22	.....	54.9	.....
Lone Star, 1913	7	37.43	32.36	2.12	.....	7.50	.....	52.9	.....
Lone Star, 1914	8	39.73	32.52	2.12	15.21	6.08	4.34	52.9	12.4
Mebane Triumph, 1913	6	38.78	32.82	1.99	.....	7.46	.....	53.9	.....
Mebane Triumph, 1914	7	38.71	33.12	2.12	15.37	6.41	4.27	53.6	11.1
Mortgage Lifter, 1913	7	39.86	32.01	2.33	.....	7.01	.....	52.9	.....
Mortgage Lifter, 1914	8	38.98	33.19	2.32	14.26	6.70	4.55	52.5	13.2
Rowden, 1913	6	36.98	34.10	2.02	.....	6.93	.....	54.6	.....
Rowden, 1914	8	37.78	33.79	2.02	15.20	6.70	4.51	54.5	14.9

Table No. 40 shows the average composition of the cotton seed kernels, arranged by varieties.

TABLE 41.—AVERAGE COMPOSITION OF SEED AND YIELDS BY VARIETIES.

	Percentage		Meal Lbs. Per Ton	Oil Gallons Available Per Ton
	Protein	Fat		
Bank Account, 1913-14	20.85	18.24	948	39.8
Black Rattler, 1913-14	21.65	20.17	984	44.6
Cleveland Big Boll, 1913-14	20.40	16.70	928	35.6
Crowder, 1913-14	20.53	18.76	933	41.3
Half and Half, 1913-14	20.77	18.05	944	39.3
Hendricks, 1913-14	21.96	17.60	999	37.6
Hogins Long Staple, 1913	20.73	18.62	942	40.9
Lone Star, 1913-14	20.41	17.16	928	36.8
Mebane Triumph, 1913-14	20.85	18.01	948	39.2
Mortgage Lifter, 1913-14	20.77	17.18	944	37.0
Rowden, 1913-14	20.41	18.54	928	40.1

Table No. 41 shows the average composition of the seed by varieties, and yields of the different varieties. Table No. 42 shows the analyses of the individual seed, arranged by varieties. This is printed in full in order that the different varieties may be compared locality by locality, if desired.

TABLE 42.—COMPOSITION OF COTTONSEED KERNELS, ARRANGED BY VARIETIES.

Laboratory Number		Protein	Ether extract	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent Kernels	Per Cent Lint
	Bank Account, 1913								
8048	Troup	40.41	31.61	2.23	.....	7.58	.....	55.0	.....
8060	Nacogdoches	36.65	33.89	2.03	.....	7.63	.....	52.5	.....
8068	Denton	40.06	32.39	1.96	.....	6.89	.....	54.8	.....
8098	Main Station	40.69	30.05	1.94	.....	9.11	.....	54.4	.....
8149	Lubbock	35.34	35.57	2.47	.....	5.46	.....	56.2	.....
8151	Lubbock	38.25	33.35	2.25	.....	6.59	.....	54.8	.....
8323	Temple	38.49	34.48	.....	.....	6.21	.....	54.0	.....
	Average	38.56	33.05	2.15	.....	7.07	.....	54.5	.....
	Bank Account, 1914.								
9316	Main Station	41.16	31.24	2.18	14.75	6.38	4.39	51.2	10.4
9782	Lubbock	35.22	35.20	.....	.....	5.74	.....	56.1	10.7
9370	Pecos	31.90	37.01	2.13	16.48	7.41	5.07	54.8	13.3
9398	Beeville	42.87	29.88	2.16	13.24	8.05	3.80	48.8	15.8
9444	Nacogfoches	36.63	35.05	1.86	16.15	6.06	4.25	54.9	12.5
9453	Spur	39.06	35.09	2.02	13.83	5.58	4.42	57.4	9.3
9463	Angleton	40.58	33.77	2.23	12.01	7.03	4.38	53.9	12.4
9716	Troup	37.37	34.60	1.86	15.44	5.90	4.83	56.9	9.0
	Average	38.10	33.98	2.06	14.70	6.60	4.56	54.3	11.7
	Black Rattler, 1913.								
8040	Troup	38.25	32.26	2.28	.....	7.73	.....	56.8	.....
8058	Nacogdoches	34.97	36.49	2.10	.....	7.11	.....	55.0	.....
8072	Denton	39.98	33.37	2.07	.....	8.53	.....	58.4	.....
8094	Main Station	39.95	30.54	.....	.....	9.42	.....	57.9	.....
8141	Pecos	33.57	38.58	.....	.....	5.49	.....	61.2	.....
8152	Lubbock	35.20	36.88	1.99	.....	5.40	.....	58.8	.....
8325	Temple	37.33	33.94	.....	.....	6.13	.....	56.2	.....
	Average	36.75	34.58	2.11	.....	7.12	.....	57.8	.....
	Black Rattler, 1914.								
9321	Main Station	38.47	33.26	.....	.....	6.34	.....	58.4	7.1
9783	Lubbock	35.18	35.91	.....	.....	5.74	.....	60.5	7.7
9367	Pecos	35.32	34.55	2.74	17.41	5.58	4.40	59.0	7
9399	Beeville	37.81	32.53	2.10	17.47	6.49	3.60	54.4	11.3
9443	Nacogdoches	37.02	34.82	2.13	15.69	6.20	4.14	60.9	7.6
9454	Spur	37.44	35.59	1.71	15.68	5.36	4.22	59.7	8.6
9464	Angleton	39.00	34.36	2.46	12.75	7.32	4.11	57.5	9.8
9717	Troup	37.95	33.75	1.95	15.41	5.97	4.97	61.6	.....
	Average	37.27	34.35	2.18	15.79	6.17	4.24	59.1	8.5
	Cleveland Big Boll, 1913.								
8006	Troup	41.30	29.69	2.47	.....	8.41	.....	49.4	.....
8062	Nacogdoches	40.23	32.01	2.36	.....	7.79	.....	51.0	.....
8086	Denton	40.42	30.63	2.32	.....	7.54	.....	51.9	.....
8100	Main Station	42.34	28.85	2.32	.....	8.77	.....	53.2	.....
8138	Pecos	32.59	38.03	.....	.....	5.85	.....	53.2	.....
8154	Lubbock	38.26	33.83	2.31	.....	6.64	.....	52.6	.....
8322	Temple	39.37	32.86	.....	.....	6.85	.....	51.5	.....
	Average	39.22	32.27	1.89	.....	6.33	.....	51.8	.....
	Cleveland Big Boll, 1914.								
9318	Main Station	41.95	30.59	.....	.....	5.95	.....	49.8	14.5
9784	Lubbock	37.96	34.55	.....	.....	6.14	.....	52.2	15.2
9368	Pecos	41.06	31.77	1.99	13.84	6.40	4.14	51.2	.....
9400	Beeville	41.95	31.84	1.93	15.19	5.16	3.93	50.2	12.3
9445	Nacogdoches	37.81	33.17	2.22	16.41	6.18	4.21	52.8	13.8
9455	Spur	39.64	33.05	2.02	13.34	7.63	4.32	50.5	14.9
9465	Angleton	41.88	32.13	2.45	10.58	8.39	4.57	50.0	15.8
9718	Troup	37.84	33.44	2.09	16.12	5.33	5.18	52.7	13.7
	Average	40.01	32.57	2.12	14.31	6.43	4.56	51.2	14.3

TABLE 42.—COMPOSITION OF COTTONSEED KERNELS, ARRANGED BY VARIETIES —Continued.

Laboratory Number		Protein	Ether extract	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent Kernels	Per Cent Lint
	Crowder, 1913.								
8042	Troup	38.56	31.14	1.98	.....	7.66	.....	55.0	.....
8050	Nacogdoches	34.72	36.44	2.04	.....	6.90	.....	52.5	.....
8070	Denton	39.61	32.75	1.87	.....	8.30	.....	54.7	.....
8143	Pecos	32.64	39.01	.....	.....	5.66	.....	55.3	.....
8146	Lubbock	37.95	35.28	1.78	.....	6.62	.....	55.8	.....
8326	Temple	37.63	33.81	.....	.....	6.04	.....	53.6	.....
	Average	36.85	34.74	1.92	.....	6.86	.....	54.5	.....
	Crowder, 1914.								
8323	Main Station	39.20	32.94	.....	.....	6.23	.....	54.4	15.1
9785	Lubbock	36.51	34.88	.....	.....	5.81	.....	56.1	14.6
9364	Pecos	39.92	33.38	2.29	14.50	5.42	4.49	53.6	13.3
9401	Beeville	39.44	32.88	1.98	16.02	6.17	3.51	50.6	16.1
9446	Nacogdoches	36.07	35.56	1.64	16.43	6.05	4.25	55.5	14.4
9456	Spur	38.09	34.66	1.97	14.69	6.24	4.35	55.7	14.9
9466	Angleton	41.35	32.93	2.40	11.37	7.60	4.33	53.5	13.8
9719	Troup	37.37	35.39	2.08	14.11	6.14	4.91	55.8	14.6
	Average	38.49	34.08	2.06	14.69	6.28	4.37	54.4	14.6
	Half and Half, 1913.								
8038	Troup	41.20	30.94	1.95	.....	7.79	.....	54.0	.....
8080	Nacogdoches	35.97	34.75	1.97	.....	7.33	.....	53.5	.....
8074	Denton	40.16	31.87	2.22	.....	8.33	.....	54.6	.....
8106	Main Station	41.90	29.90	.....	.....	8.86	.....	54.5	.....
8144	Pecos	34.87	36.03	2.13	.....	5.95	.....	55.9	.....
8148	Lubbock	36.15	35.53	1.94	.....	6.01	.....	54.7	.....
	Average	38.38	33.17	2.04	.....	7.38	.....	54.5	.....
	Half and Half, 1914.								
9317	Main Station	40.58	31.54	.....	.....	5.98	.....	51.8	10.9
9786	Lubbock	36.56	33.75	.....	.....	5.57	.....	56.1	10.7
9363	Pecos	36.31	34.02	4.15	14.88	5.84	4.80	53.8	10.5
9402	Beeville	38.42	31.78	2.15	17.48	6.46	3.71	52.0	16.6
9447	Nacogdoches	39.53	33.55	2.30	14.38	5.99	4.25	56.9	10.8
9457	Spur	37.63	34.55	2.02	14.69	6.71	4.40	52.0	11.6
9467	Angleton	39.83	33.72	2.56	12.32	7.13	4.44	54.5	12.8
9720	Troup	35.98	33.42	3.10	16.97	5.86	4.67	56.0	10.9
	Average	38.11	33.29	2.71	15.32	6.19	4.38	54.1	11.9
	Lone Star, 1913.								
8032	Troup	38.97	30.53	.....	.....	8.27	.....	49.3	.....
8056	Nacogdoches	37.41	34.06	.....	.....	7.64	.....	55.0	.....
8064	Denton	39.69	30.73	.....	.....	8.61	.....	53.5	.....
8090	Main Station	35.23	30.13	2.12	.....	9.15	.....	50.1	.....
8140	Pecos	35.85	35.57	.....	.....	5.52	.....	56.0	.....
8145	Lubbock	36.90	33.03	.....	.....	6.70	.....	54.2	.....
8328	Temple	37.95	32.46	.....	.....	6.61	.....	52.0	.....
	Average	37.43	32.36	2.12	.....	7.50	.....	52.9	.....
	Lone Star, 1914.								
9320	Main Station	40.63	31.28	.....	.....	6.40	.....	52.0	12.2
9788	Lubbock	37.01	33.75	.....	.....	6.47	.....	54.0	12.7
9365	Pecos	39.81	32.06	2.50	15.12	5.68	4.83	50.2	13.9
9404	Beeville	41.21	30.94	1.85	15.61	6.80	3.59	49.5	15.2
9449	Nacogdoches	39.95	33.95	1.82	14.58	5.37	4.33	54.4	12.9
9459	Spur	38.25	32.51	2.10	17.88	5.00	4.26	53.2	11.3
9469	Angleton	41.48	32.69	2.21	12.49	6.83	4.30	53.6	10.8
9722	Troup	39.50	33.00	2.23	14.45	6.08	4.74	55.9	9.8
	Average	39.73	32.52	2.12	15.21	6.08	4.34	52.9	12.4
	Hendricks, 1913.								
8034	Troup	40.59	31.61	2.34	.....	8.40	.....	54.6	.....
8066	Denton	39.86	30.48	2.38	.....	8.63	.....	55.0	.....
8096	Main Station	38.18	29.07	.....	.....	9.19	.....	54.8	.....
	Average	39.54	30.39	2.36	.....	8.74	.....	54.8	.....

TABLE 42.—COMPOSITION OF COTTONSEED KERNELS, ARRANGED BY VARIETIES —Continued.

Laboratory Number		Protein	Ether Extract	Crude Fiber	Nitrogen Free Extract	Water	Ash	Per Cent Kernels	Per Cent Lint
	Hendricks, 1914.								
9324	Main Station	39.97	32.36	.....	.....	5.97	.....	54.4	.....
9787	Lubbock	37.29	34.53	.....	.....	6.95	.....	56.0	6.0
9362	Pecos	40.85	31.36	2.27	14.73	6.26	4.53	56.4	6.9
9403	Beeville	38.56	32.66	1.87	16.76	6.42	3.73	54.7	12.0
9448	Nacogdoches	39.06	33.61	1.61	15.36	6.11	4.25	58.2	9.1
9458	Spur	38.28	32.86	2.61	14.74	7.15	4.36	58.6	7.1
9468	Angleton	40.00	33.66	2.45	13.88	5.61	4.40	55.6	10.0
9721	Troup	40.40	31.43	2.43	14.06	6.99	4.69	58.8	5.7
	Average	39.30	32.81	2.21	14.92	6.43	4.33	56.6	7.1
	Mebane Triumph, 1913.								
8036	Troup	41.36	31.08	2.39	.....	8.54	.....	51.8	.....
8052	Nacogdoches	37.01	34.53	1.94	.....	6.71	.....	53.0	.....
8084	Denton	39.86	31.20	.....	.....	6.55	.....	53.4	.....
8092	Main Station	40.04	29.49	1.69	.....	9.09	.....	53.4	.....
8139	Pecos	36.22	36.37	.....	.....	.....	.....	55.4	.....
8155	Lubbock	38.20	34.22	1.95	.....	6.41	.....	55.4	.....
	Average	38.78	32.82	1.99	.....	7.46	.....	53.7	.....
	Mebane Triumph, 1914.								
8322	Main Station	41.07	31.60	.....	.....	6.26	.....	52.4	12.4
9789	Lubbock	17.17	34.23	.....	.....	6.55	.....	54.5	12.1
9366	Pecos	37.54	33.26	2.10	17.00	5.42	4.68	52.2	7.7
9405	Beeville	39.51	33.23	2.05	15.28	6.41	3.52	51.0	.....
9450	Nacogdoches	37.73	34.10	1.30	17.14	5.55	4.18	54.6	12.8
9460	Spur	38.35	33.25	2.71	13.41	8.01	4.17	55.4	10.8
9723	Troup	39.57	32.06	2.45	14.41	6.70	4.81	55.2	10.9
	Average	38.71	33.12	2.12	15.37	6.41	4.27	53.6	11.1
	Mortgage Lifter, 1913.								
8044	Troup	49.72	29.63	1.98	.....	7.78	.....	52.2	.....
8082	Nacogdoches	38.67	33.14	3.24	.....	7.60	.....	52.5	.....
8076	Denton	41.01	30.96	.....	.....	7.98	.....	52.5	.....
8102	Main Station	42.36	28.98	2.15	.....	6.52	.....	51.4	.....
8147	Lubbock	36.16	35.93	1.96	.....	5.66	.....	54.5	.....
8153	Lubbock	38.95	33.17	.....	.....	6.98	.....	53.7	.....
8327	Temple	40.13	32.29	.....	.....	6.52	.....	53.3	.....
	Average	39.86	32.01	2.33	.....	7.01	.....	52.9	.....
	Mortgage Lifter, 1914.								
9319	Main Station	43.44	29.21	.....	.....	6.16	.....	50.0	13.7
9790	Lubbock	34.21	35.88	.....	.....	6.52	.....	52.0	12.1
9369	Pecos	35.06	35.61	2.03	16.10	6.22	4.98	50.8	15.2
9406	Beeville	41.73	31.82	2.11	13.52	7.12	3.70	51.4	13.3
9451	Nacogdoches	38.08	34.04	2.20	14.61	6.60	4.47	55.8	16.0
9461	Spur	38.48	33.18	2.87	13.45	7.64	4.38	54.8	11.9
9470	Angleton	39.63	33.33	2.38	13.02	7.18	4.46	51.6	10.7
9724	Troup	41.20	32.41	2.30	13.28	5.78	5.03	53.6	12.9
	Average	38.98	33.19	2.32	14.26	6.70	4.55	52.5	13.2
	Rowden, 1913.								
8046	Troup	40.76	31.55	1.77	.....	7.62	.....	54.0	.....
8054	Nacogdoches	35.22	37.06	1.92	.....	6.53	.....	53.5	.....
8078	Denton	35.84	32.50	.....	.....	8.77	.....	54.7	.....
8104	Main Station	41.75	30.05	1.89	.....	7.26	.....	54.6	.....
8142	Pecos	32.69	37.95	2.80	.....	5.86	.....	55.3	.....
8150	Lubbock	35.61	35.51	1.73	.....	5.55	.....	55.6	.....
	Average	36.98	34.10	2.02	.....	6.93	.....	54.6	.....
	Rowden, 1914.								
9325	Main Station	39.22	32.84	2.18	15.72	5.83	4.21	54.8	13.7
9791	Lubbock	36.34	34.58	.....	.....	6.79	.....	56.2	14.2
9361	Pecos	33.54	36.49	2.25	17.15	5.66	4.91	53.4	18.6
9407	Beeville	37.23	32.73	1.84	16.86	7.57	3.77	52.5	10.7
9452	Nacogdoches	36.90	34.35	1.74	16.05	6.37	4.59	55.0	17.1
9462	Spur	36.80	34.03	2.45	14.64	7.50	4.58	55.7	14.4
9471	Angleton	41.38	32.60	2.09	11.78	7.78	4.37	52.4	14.0
9725	Troup	40.80	32.71	1.61	13.61	6.10	5.17	56.3	16.2
	Average	37.78	33.79	2.02	15.20	6.70	4.51	54.5	14.9

There is an average difference in the varieties, and also differences in the same variety when grown in different places. Some of the differences are due to soil conditions, climatic conditions, soil fertility, and the degree of maturity of the cotton when picked, as well as to the variety of the seed. The proportion of hull to kernel, however, affects decidedly the yield of oil. The seed richest in oil is the Black Rattler. This seed also contains the highest percentage of kernel, but the kernels are also rich in oil. The Cleveland Big Boll is poorest in oil, and contains the lowest percentage of kernels. In 1914, it carried 14.3 per cent. lint, or nearly 6 per cent. more than the Black Rattler, and with closer ginning should show up better in percentage of hulls and oil. The next lowest is the Lone Star, and the percentage of kernels is likewise low.

The seed of the Black Rattler and the Cleveland Big Boll were grown two years at seven or eight different substations, and showed, on the average, the differences given above. Table No. 43 shows that a comparison of the individual lots grown in the different stations shows the Black Rattler in every case to produce seed richer in oil and with a larger percentage of kernels than the Cleveland Big Boll. It is thus clearly evident that some varieties of cotton naturally produce seed combining more oil than other varieties. The average difference between these two varieties is 9 gallons per ton, which, at 40 cents per gallon, would be $3.60 per ton difference in value.

It ought, therefore, to be possible to select varieties of cotton which produce a seed rich in oil. Cotton is, however, primarily grown for its lint, since the lint is much more valuable than the seed. Yield or quality of lint could not be sacrificed to yield of oil. It would be possible, however, to select seed which would at the same time produce a high quality and quantity of lint, and a high quantity of oil.

Apparently the proportion of kernels to meats offers a crude method for approximately judging extreme differences in the quantity of oil produced from different seeds. This requires further study.

COMPOSITION OF SEED FROM DIFFERENT TEXAS LOCALITIES.

Table No. 43 contains the analyses of a number of samples of seed as made by a Texas oil mill from seed secured from various parts of the State. The available yields are calculated on a basis of 44.6 per cent. protein and 6.8 per cent. fat in the meal, and a milling loss of 7 per cent. The mill can, of course, afford to pay a higher price for seed that contain larger quantities of oil,—or, to take it the other way, they cannot afford to pay so much for seed low in oil. The table shows that different lots of seed from the same locality may vary considerably in oil content. At Goliad, for example, there is the difference between 37 and 44 gallons, or 7 gallons oil per ton in two different shipments. The average for Goliad (seven lots) is 39 gallons, and for Robstown 36 gallons, a difference of 3 gallons per ton, or $1.20 at 40 cents per gallon.

TABLE 43.—COMPOSITION OF TEXAS COTTONSEED, AS FOUND BY AN OIL MILL.

Date	Origin	Weight 100 Seed	Per Cent Meats	Per Cent Water	Per Cent Oil	Per Cent Ammonia	Per Cent Damaged	Per Cent Rotten	Oil Gallons	Oil Lbs.	Hulls and Lint Lbs.	Meal Lbs.
Dec. 13, 1915	South West Texas (Average)	10.5835	52.72	7.72	16.32	4.21	3	.....	34	255.4	699.6	905
Dec. 13, 1915	West Texas (Average)	11.7032	54.06	7.69	11.62	4.21	2.9	.8	39	291.2	663.8	905
Dec. 13, 1915	South Texas (Average)	11.5239	52.31	7.56	17.66	4.14	3.1	.6	39	293.3	676.9	889.8
Dec. 13, 1915	Central Texas (Average)	11.5806	52.95	7.63	17.65	4.21	2.5	.6	39	292.1	662.9	905
Dec. 13, 1915	East Texas (Average)	11.7262	53.80	7.24	17.92	4.10	3.1	1.8	40	299.5	688.7	871.8
Oct. 9, 1915	Austin	11.7869	54.68	7.00	17.22	4.33	4	.....	37	282	648	930
Oct. 2, 1915	Austin	11.9400	54.00	8.48	18.84	4.45	.....	1	41	313	590	957
Oct. 30, 1915	Arp	10.8553	53.60	6.13	17.76	4.13	10	.....	39	296	677	887
Sept. 16, 1915	Aqua Dulce	10.7497	51.94	8.64	16.38	4.22	2	.....	35	264	689	907
Oct. 30, 1915	Appleby	11.1202	49.12	5.90	16.15	3.93	4	.....	35	267	751	842
.....	Anderson	11.6748	50.42	7.54	17.97	3.82	4	.....	40	304	735	821
Oct. 30, 1915	Burnett	11.9133	53.44	5.53	17.56	4.16	2	.....	38	291	675	894
Oct. 22, 1915	Bryan	10.6986	50.83	8.69	18.29	4.15	6	1	40	306	663	891
Oct. 8, 1915	Bryan	11.2872	52.60	8.36	17.44	4.29	.....	.....	38	287	651	922
Oct. 13, 1915	Brookshire	11.6250	50.80	7.60	17.62	4.04	6	4	39	294	699	867
Oct. 23, 1915	Brenham	11.9281	53.95	7.56	18.85	4.04	2	.....	42	319	699	872
Oct. 30, 1915	Boynton	11.6495	50.04	6.12	16.81	3.92	6	6	37	280	738	840
Sept. 19, 1915	Bloomington	11.3707	52.07	8.60	17.15	3.83	6	.....	38	288	729	823
Oct. 25, 1915	Blanchard	13.1400	56.50	6.76	19.70	4.32	4	2	44	332	599	929
Oct. 30, 1915	Blair	11.5790	51.31	6.03	17.82	4.10	.....	.....	39	297	682	881
Oct. 30, 1915	Benchly	10.2151	51.80	6.18	17.39	4.26	2	2	38	287	667	916
Sept. 24, 1915	Ben Arnold	11.0328	54.67	7.58	18.79	4.10	.....	.....	42	316	663	881
Sept. 21, 1915	Beeville	11.4001	54.46	7.16	17.52	4.27	4	.....	38	289	653	918
Aug. 16, 1915	Beeville	10.0633	50.88	6.32	18.47	4.19	.....	.....	41	309	651	900
Aug. 13, 1915	Beeville	10.5337	51.18	6.62	18.47	4.26	.....	.....	41	308	638	914
Aug. 10, 1915	Beeville	11.1707	50.61	5.02	18.63	3.81	6	.....	42	317	725	818
Aug. 12, 1915	Beeville	10.4758	51.83	6.93	17.61	4.20	6	.....	38	290	671	901
Aug. 12, 1915	Beeville	10.5917	50.18	6.88	18.22	4.26	2	.....	40	303	643	914
Aug. 14, 1915	Beeville	10.6977	50.83	6.58	16.69	4.19	8	.....	36	274	686	900
Aug. 14, 1915	Beeville	10.1077	52.32	7.18	16.71	4.21	8	.....	36	274	682	904
Oct. 10, 1915	Bechville	11.8360	54.32	7.19	19.42	3.83	4	.....	44	333	704	823
Oct. 22, 1915	Ballinger	11.8046	53.08	7.88	16.95	4.12	7	2	37	280	695	885
Nov. 5, 1915	Ballinger	11.7724	55.62	8.15	17.82	4.37	.....	.....	39	293	628	939
Oct. 23, 1915	Bastrop	11.8396	53.41	7.20	18.05	4.29	2	2	39	299	639	922
Oct. 8, 1915	Bastrop	12.0475	52.39	7.74	17.80	4.21	2	2	39	295	860	905
Sept. 16, 1915	Bastrop	11.7287	53.06	7.98	16.04	3.95	4	2	35	264	748	848
Sept. 16, 1915	Bastrop	12.3196	53.72	7.40	19.60	4.08	2	.....	44	333	651	876
Oct. 21, 1915	Cuero	11.4355	52.92	8.40	17.17	4.10	.....	.....	37	284	694	882
Oct. 11, 1915	Cuero	11.5157	53.32	7.75	17.23	4.11	.....	.....	38	286	690	884
Sept. 23, 1915	Cuero	11.2777	51.33	7.83	17.76	4.22	4	.....	39	294	661	905
Sept. 24, 1915	Cuero	11.4927	55.30	7.59	17.96	3.74	.....	.....	40	305	715	840

Sept. 20, 1915	Cuero	11.5416	51.32	7.48	18.39	4.07	2		41	309	677	874
Sept. 19, 1915	Cuero	11.8449	52.70	8.55	16.39	4.19	6		35	267	697	900
Aug. 16, 1915	Cuero	12.1867	52.55	6.96	17.61	3.83	2		39	297	741	822
Aug. 16, 1915	Cuero	11.4527	53.49	6.98	17.31	3.95			38	289	723	848
Sept. 15, 1915	Cuero	11.3751	52.14	7.30	17.04	3.90			38	286	764	810
Oct. 12, 1915	Crosby	9.9506	51.20	7.87	16.20	4.31	6	4	34	262	671	927
Oct. 25, 1915	Crockett	11.6114	54.14	6.89	19.06	4.14	4	2	42	321	649	890
Oct. 30, 1915	Courtney	11.0496	52.15	6.24	16.66	4.28			36	271	668	921
Oct. 30, 1915	Crosby	8.8249	44.75	6.76	13.73	4.65	18	4	26	201	659	1000
Oct. 23, 1915	Corsicana	11.4825	54.80	7.02	18.04	4.44	6		39	297	608	955
Oct. 12, 1915	Corsicana	11.6338	54.56	7.95	16.20	4.53			35	269	617	974
Oct. 30, 1915	Cornal	11.1740	52.46	5.84	17.28	3.88	2		39	290	736	834
Oct. 23, 1915	Clay	11.5376	51.94	7.63	16.35	4.25	2	2	36	270	677	913
Sept. 23, 1915	Charlotte	10.4714	53.50	6.81	16.27	4.21	4		36	274	682	904
Oct. 25, 1915	Center	10.4144	51.76	7.26	17.22	4.22	4	10	37	283	670	907
Oct. 30, 1915	Casa Blanca	10.6292	51.22	5.76	16.10	4.35	4	2	34	259	666	935
Oct. 30, 1915	Carthage	11.8562	53.00	5.80	19.57	4.07	4	2	44	332	654	874
Oct. 25, 1915	Cameron	11.6210	53.62	7.04	18.05	4.19	2	2	40	301	659	900
Oct. 23, 1915	Caldwell	11.1329	52.41	7.52	16.85	4.13	4	2	37	278	694	888
Oct. 7, 1915	Caldwell	10.1595	48.50	8.01	16.76	4.14			36	275	695	890
Oct. 12, 1915	Dayton	10.6474	50.08	8.02	15.66	4.27		14	33	252	691	917
Sept. 20, 1915	Dilley	9.5974	51.59	7.05	18.22	4.10	10		40	305	663	882
Nov. 5, 1915	Floresville	11.2054	53.11	8.19	17.81	4.43	4		39	292	616	952
Oct. 30, 1915	Elkhart	11.2624	54.39	6.05	16.72	4.05	4	2	36	276	764	820
Oct. 25, 1915	Goliad	11.8647	54.11	6.86	16.87	4.16	6		37	277	689	894
Oct. 7, 1915	Goliad	11.4515	54.21	7.68	16.98	4.11	4		37	281	697	882
Aug. 16, 1915	Goliad	11.9682	51.62	6.10	17.50	4.20	4		38	290	668	902
Aug. 12, 1915	Goliad	12.1517	54.17	7.13	19.48	4.14	4		44	330	641	889
Aug. 12, 1915	Goliad	11.5498	51.07	6.90	17.82	4.38	6		38	287	533	940
Aug. 10, 1915	Goliad	12.4002	54.21	6.66	18.63	4.30			41	310	627	923
Aug. 14, 1916	Goliad	11.8561	51.71	6.69	17.86	4.17	6		39			
Oct. 8, 1915	Gonzales	11.6570	52.3	8.27	18.30	4.26	4		40	305	639	916
Sept. 23, 1916	Gonzales	12.1477	52.27	8.76	18.24	4.01			40	307	692	861
Aug. 13, 1916	Gonzales	10.8839	52.09	6.84	19.02	3.99	2		42	323	681	856
Jan. 14, 1915	Gonzales	11.7896	53.50	7.14	17.79	4.13	4		39	296	677	887
Oct. 23, 1915	Gonzales	11.4277	51.90	7.28	17.94	4.37	2	2	39	296	625	939
Oct. 23, 1915	Grapeland	11.5980	54.0	7.07	16.87	4.37	2		36	274	646	940
Sept. 20, 1915	Green	11.1832	52.16	7.01	17.80	4.13			39	297	675	888
Sept. 23, 1915	Green	11.3865	54.41	7.86	17.08	4.15			37	231	688	891
Sept. 15, 1915	Green	11.0023	54.14	7.12	16.79	4.12	4		36	277	708	875
Oct. 12, 1915	Groesbeck	10.8737	51.44	7.92	16.10	4.25	6		34	260	673	914
Nov. 5, 1915	Halletsville	12.4044	54.31	8.15	18.98	3.95	4		43	323	690	847
Oct. 8, 1915	Halletsville	11.6525	50.85	8.03	17.92	3.83	2		40	302	736	822
Oct. 8, 1915	Henderson	11.9116	50.80	7.26	17.60	3.69	8		39	299	768	793
Oct. 22, 1915	Henderson	11.8810	54.13	8.61	17.32	3.95	4		38	289	723	848
Sept. 16, 1915	Karnes City	10.3457	54.54	7.38	17.80	4.25	4		39	295	651	914
Sept. 16, 1915	Kenedy	10.8593	50.23	7.58	18.38	3.88	4		41	311	715	834
Aug. 16, 1915	Kenedy	11.6513	54.60	5.74	17.79	4.01			39	298	701	861
Aug. 13, 1915	Kenedy	11.0540	53.96	6.60	17.58	4.29	2		38	290	649	921
July 4, 1915	Kenedy	11.0287	54.04	6.90	17.44	4.29	4		38	287	653	920
Nov. 5, 1915	Kosse	11.8032	53.54	8.00	18.23	3.94			41	308	705	847

TABLE 43.—COMPOSITION OF TEXAS COTTONSEED, AS FOUND BY AN OIL MILL.

Date	Origin	Weight 100 Seed	Per Cent Meats	Per Cent Water	Per Cent Oil	Per Cent Ammonia	Per Cent Damaged	Per Cent Rotten	Oil Gallons	Oil Lbs.	Hulls and Lint Lbs.	Meal Lbs.
Sept. 20, 1915	La Ward	12.0702	50.60	11.16	15.90	3.82	.....	8	35	213	681	816
Oct. 30, 1915	Leggett	9.9445	52.12	6.30	16.17	4.31	2	.....	34	261	672	927
Oct. 22, 1915	Liberty Hill	11.3492	53.19	7.87	17.13	4.19	2	1	37	282	678	900
Aug. 10, 1915	Lindenan	11.4575	53.02	5.26	18.56	4.11	4	.....	41	312	665	883
Oct. 25, 1915	Livingston	11.1521	52.81	7.25	18.45	4.18	6	6	41	309	662	889
Sept. 13, 1915	Livingston	13.1753	47.41	.....	17.95	3.57	.....	12	41	310	784	766
Oct. 7, 1915	Livingston	11.2967	52.44	7.11	18.12	3.76	2	4	40	303	749	808
Oct. 8, 1915	Lockhart	11.6885	52.53	7.97	16.97	3.99	2	.....	37	282	724	857
Oct. 9, 1915	Lovelady	11.2788	53.59	6.80	17.10	3.67	2	.....	38	291	781	788
Nov. 5, 1915	Luling	11.9783	55.42	8.01	17.48	3.95	.....	.....	39	293	719	848
Sept. 16, 1915	Luling	11.0373	52.72	7.30	17.61	4.11	.....	.....	39	293	683	884
Aug. 16, 1915	Luling	11.7052	46.48	5.96	16.18	4.14	4	.....	35	263	707	890
Oct. 22, 1915	Manor	11.9892	54.20	7.73	18.37	4.28	1	1	40	305	636	919
Oct. 7, 1915	Manor	11.8514	51.55	7.20	17.12	4.02	6	.....	37	284	711	865
Sept. 16, 1915	Marion	12.5167	54.21	7.48	17.12	4.00	2	.....	38	284	720	859
Oct. 22, 1915	Marion	11.7350	53.44	8.33	17.32	4.01	3	.....	38	288	711	861
Oct. 30, 1915	Marlin	11.4490	52.91	6.00	17.57	4.16	6	.....	38	291	674	895
Sept. 15, 1915	Mathis	11.2010	51.98	7.56	17.56	3.81	2	.....	39	297	852	809
Aug. 14, 1915	Mandlow	10.8466	52.18	7.08	18.07	3.92	.....	.....	40	.....	.....	.....
Oct. 19, 1915	Mexia	10.4899	51.55	7.04	16.41	4.45	6	.....	35	264	650	956
Oct. 30, 1915	Montgomery	11.6151	52.35	6.22	16.95	4.04	2	.....	37	281	712	867
Oct. 13, 1915	Mt. Enterprise	11.4763	52.70	7.68	17.92	4.16	4	.....	39	298	669	893
Oct. 25, 1915	Nacogdoches	11.8560	51.90	7.03	17.95	4.00	8	4	40	301	700	859
Oct. 8, 1915	Nacogdoches	11.9327	51.00	7.37	17.22	4.38	2	.....	37	282	637	941
Nov. 5, 1915	New Braunfels	12.2669	53.92	8.08	18.64	4.22	.....	.....	41	312	642	906
Oct. 9, 1915	New Braunfels	11.9816	52.93	6.86	17.30	4.10	6	.....	38	287	692	881
Sept. 19, 1915	New Braunfels	12.1742	50.86	8.41	15.77	4.15	6	.....	34	255	713	892
Sept. 21, 1915	New Braunfels	12.0521	52.71	7.25	18.53	3.98	2	.....	41	313	692	855
Aug. 16, 1915	New Braunfels	12.6619	52.62	6.92	16.89	3.73	2	.....	37	283	775	802
Sept. 15, 1915	New Braunfels	12.1071	53.69	7.67	17.95	4.22	4	.....	39	298	601	907
Sept. 20, 1915	Nordheim	10.3911	51.78	7.20	16.48	4.17	4	.....	35	269	695	896
Aug. 12, 1915	Nordheim	10.9290	52.87	6.72	19.56	4.39	6	.....	41	309	609	942
Aug. 14, 1915	Nordheim	11.1561	52.47	6.81	17.43	4.31	6	.....	35	286	742	932
Aug. 16, 1915	Nordheim	11.5870	49.08	6.80	16.96	4.03	.....	.....	39	291	703	866
Sept. 24, 1915	Oakwood	11.1762	55.49	7.90	19.21	3.75	.....	.....	43	325	728	806
Sept. 19, 1915	Odem	11.1612	53.37	8.37	16.99	4.23	.....	.....	37	278	677	905
Sept. 16, 1915	Odem	11.0842	54.54	8.00	15.14	4.26	4	.....	32	241	704	915
Aug. 13, 1915	Odem	10.7896	53.70	6.84	16.91	4.27	2	.....	27	277	667	916
Aug. 10, 1915	Odem	11.7865	51.19	6.78	17.55	4.04	4	.....	39	292	700	868
Oct. 25, 1915	Overton	11.2965	53.20	6.70	17.91	4.07	6	.....	39	299	686	875
Oct. 9, 1915	Palestine	11.8502	54.92	7.20	17.59	3.95	.....	2	39	295	717	848
Oct. 23, 1915	Palestine	11.8845	54.70	7.25	18.88	4.09	2	.....	42	319	662	879

Oct. 30, 1915	Paxton	10.5226	54.62	5.86	18.67	3.85	6		42	318	716	826
Sept. 20, 1915	Pearsall	10.7862	50.64	7.28	15.84	4.48	6		33	253	670	937
Oct. 7, 1915	Robstown	11.1420	51.45	6.88	16.80	4.27	4		36	275	678	919
Sept. 20, 1915	Robstown	10.5989	53.93	7.53	17.89	4.41	4		39	295	618	947
Sept. 20, 1915	Robstown	10.9250	54.04	6.95	16.50	4.29	2		35	268	670	922
Sept. 19, 1915	Robstown	10.7727	53.35	7.00	15.52	4.48	2		32	246	654	960
Aug. 13, 1915	Robstown	10.6272	53.03	6.72	17.07	4.46			37	278	621	957
Sept. 15, 1915	Robstown	10.7846	51.45	7.67	16.29	4.18	2		35	264	710	886
Nov. 5, 1915	Rosebud	12.4555	55.66	9.95	18.63	4.25	2		41	311	635	914
Sept. 23, 1915	Rosebud	10.5942	53.59	8.05	16.41	4.40	4		35	265	649	946
Nov. 5, 1915	Rosenberg	10.5954	51.19	8.12	16.13	4.28	6	2	34	260	680	920
Aug. 12, 1915	Runge	10.7431	52.26	6.84	17.63	4.20	6		39	292	667	901
Sept. 23, 1915	St. Paul	10.5599	57.00	7.72	17.96	4.42			39	294	616	950
Oct. 30, 1915	Salina	11.5153	54.21	5.78	18.17	4.05	4		40	305	684	871
Oct. 5, 1915	San Augustine	12.7317	51.31	7.88	18.00	4.09		2	40	301	680	879
Oct. 22, 1915	Seguin	12.0624	53.85	8.20	18.19	4.12	3	1	40	304	671	885
Oct. 8, 1915	Seguin	11.8200	52.05	7.70	18.05	3.88	6		40	305	721	834
July 17, 1915	Seguin	11.4475	52.77	8.36	17.27	4.09	4		38	287	696	879
Sept. 24, 1915	Seguin	11.9648	55.78	7.82	18.77	3.75			43	321	739	800
Sept. 16, 1915	Seguin	12.3550	54.24	7.31	18.93	4.11	4		42	319	657	884
Aug. 14, 1915	Seguin	11.4287	52.54	6.38	16.18	4.36	2		34	261	663	936
Aug. 16, 1915	Seguin	11.8656	53.30	5.79	17.32	4.19	2		38	285	675	900
Aug. 16, 1915	Seguin	11.2040	54.18	7.02	17.88	4.22	4		39	296	556	908
Sept. 4, 1915	Seguin	10.8719	52.64	7.00	15.80	4.20	4		34	256	704	900
Oct. 25, 1915	Shepherd	12.5267	51.35	6.98	18.62	4.27		2	42	310	638	918
Oct. 13, 1915	Shiner	12.0959	52.72	8.15	17.96	4.45	4	2	39	295	609	956
Sept. 15, 1915	Shiner	11.7387	48.85	7.12	18.42	4.28	4		40	305	635	920
Sept. 1, 1915	Shiner	12.0938	53.22	6.97	17.03	4.09			37	281	700	879
Sept. 15, 1915	Shiner	12.4288	50.76	7.18	18.97	4.13	2		43	323	649	888
Aug. 16, 1915	Shiner	12.2902	54.38	8.86	19.12	3.94	6		43	327	686	847
Oct. 13, 1915	Shire	11.5469	52.19	7.81	16.54	4.14	2	2	36	272	700	888
Sept. 9, 1915	Skidmore	9.9048	50.94	7.12	16.62	4.19	4		36	272	688	900
Oct. 7, 1915	Stafford	10.4296	50.48	7.43	16.74	3.88	4		38	279	747	834
Sept. 23, 1915	Stafford	12.0249	54.51	7.55	17.18	4.23		2	37	282	650	908
Sept. 6, 1915	Stafford	12.0122	53.46	15.52	16.58	3.97		2	36	275	731	854
Oct. 13, 1915	Sugarland	12.5001	54.03	7.98	17.35	3.95	2	2	38	290	722	848
Sept. 20, 1915	Victoria	11.7854	50.07	7.59	18.41	4.02	6		41	310	686	864
Aug. 14, 1915	Victoria	11.8928	54.02	6.75	17.83	4.07	2		39			
Aug. 10, 1915	Victoria	11.1669	45.53	5.50	18.43	4.64	4	12	40	301	563	996
Sept. 16, 1915	Taft	10.9077	55.84	7.97	16.73	4.42	2		36	271	639	750
Sept. 16, 1915	Taft	10.6448	55.61	7.12	17.97	4.30	4		39	297	639	924
Aug. 16, 1915	Taft	11.1876	55.05	6.45	16.85	4.22	4		36	276	677	907
Nov. 5, 1915	Taylor	11.9040	55.00	8.11	18.11	4.29			40	300	637	923
Oct. 30, 1915	Thomaston	11.5027	52.92	6.02	17.13	3.88			38	286	740	834
Aug. 12, 1915	Thomaston	12.0465	53.84	6.69	18.52	4.25	2		41	309	639	912
Aug. 10, 1915	Thomaston	11.0010	52.12	5.81	17.67	4.16	6		39	293	673	894
Aug. 14, 1915	Thomaston	12.282	51.61	6.64	17.61	4.09	4		38	291	654	915
Aug. 16, 1915	Thomaston	12.7328	52.61	6.92	17.25	4.01	2		38	291	757	812
Oct. 23, 1915	Thorndale	11.6830	53.95	7.11	17.88	4.28	4		39	296	644	920
Oct. 23, 1915	Timpson	11.9721	52.88	7.22	18.78	4.50	4	4	41	311	581	968
Sept. 19, 1915	Tynan	10.6962	53.39	8.81	15.76	4.46	4		34	261	639	960

TABLE 43.—COMPOSITION OF TEXAS COTTONSEED, AS FOUND BY AN OIL MILL.

Date	Origin	Weight 100 Seed	Per Cent Meats	Per Cent Water	Per Cent Oil	Per Cent Ammonia	Per Cent Damaged	Per Cent Rotten	Oil Gallons	Oil Lbs.	Hulls and Lint Lbs.	Meal Lbs.
Oct. 23, 1915	Waelder	11.5264	53.24	7.37	17.87	4.27	6	2	39	296	647	917
Oct. 8, 1915	Waelder	12.0117	51.67	7.59	17.13	4.14	.....	.....	37	282	688	890
Sept. 21, 1915	Waelder	10.7727	53.78	7.04	17.94	4.09	.....	.....	40	300	682	879
Oct. 8, 1915	Weimar	12.1657	50.00	7.43	16.90	4.14	4	4	37	278	692	890
Sept. 24, 1915	Weimar	12.3438	55.85	7.38	17.76	4.14	.....	.....	39	295	676	889
Sept. 16, 1915	Weimar	12.4560	49.69	8.38	16.46	4.17	12	.....	35	269	695	896
Oct. 25, 1915	Westhoff	10.0950	52.33	7.00	18.03	3.75	.....	2	40	306	748	806
Oct. 9, 1915	Westhoff	10.5811	52.41	7.00	17.21	4.08	6	.....	37	283	700	877
Sept. 20, 1915	Westhoff	11.0576	51.35	7.31	17.64	4.10	4	.....	39	294	685	881
Sept. 23, 1915	Westhoff	10.9512	53.38	8.04	16.36	3.99	.....	.....	36	270	733	857
Sept. 4, 1915	Westhoff	11.5098	49.08	7.86	17.24	3.90	4	.....	38	288	734	838
Sept. 4, 1915	Westhoff	11.5301	51.88	6.65	17.21	4.19	4	.....	38	284	676	900
Sept. 15, 1915	Westhoff	11.1876	52.18	7.21	17.40	4.02	2	.....	38	290	707	863
Oct. 30, 1915	Whitehouse	11.9073	54.09	5.63	18.12	4.12	.....	.....	40	303	672	885
Oct. 8, 1915	Willis	11.9754	50.35	8.05	17.42	4.09	4	6	38	289	693	878
Sept. 19, 1915	Woodsboro	11.0684	51.17	8.21	16.30	4.31	8	.....	35	264	669	927
Sept. 16, 1915	Woodsboro	10.9935	54.83	7.47	18.66	4.27	2	.....	41	312	632	916
Oct. 30, 1915	Woodsboro	11.3800	54.43	5.94	18.39	4.55	.....	.....	40	303	579	978
Oct. 7, 1915	Wortham	11.0223	51.40	7.92	17.21	4.18	2	.....	37	284	676	900
Sept. 16, 1915	Yoakum	11.7777	53.73	8.00	16.43	4.12	.....	.....	35	269	706	885
Aug. 13, 1915	Yoakum	11.7869	52.32	6.95	17.81	4.11	.....	.....	39	292	705	863
Aug. 13, 1915	Yoakum	11.3491	51.67	6.74	18.69	4.11	4	.....	42	315	663	882
Sept. 16, 1915	Yorktown	10.8943	52.58	7.50	18.15	4.19	4	.....	40	303	657	900
Aug. 10, 1915	Yorktown	11.0416	51.82	5.14	16.53	3.75	4	.....	35	261	794	805
Aug. 10, 1915	Yorktown	10.6102	49.49	5.14	19.93	3.96	8	.....	45	343	667	850
Aug. 12, 1915	Yorktown	11.2930	53.72	7.05	18.71	4.10	2	.....	42	314	666	880
Aug. 16, 1915	Yorktown	11.5509	50.27	9.19	18.18	3.88	6	.....	40	307	619	834
	Average	11.4200	52.62	7.30	17.49	4.13	3	0.8	38	291	681	887

Since the shipments from the same town may come from different localities in the tributary district, and since soil, season, variety, and ripeness affect the composition, a number of analyses from each locality, averaged for several years, would be required to bring out clearly the locality differences. Seed from Bryan, for example, may come from cotton on the upland, or from cotton grown in the Brazos bottom. The table, however, is very valuable, and the writer hopes that other oil millls in the State will supplement this data from analyses made for them.

COMPOSITION OF SELECTIONS.

Table No. 44 contains analyses of a number of selections of the same variety of seed, grown under similar conditions at College Station by Mr. Jobson. In order to avoid the influence of varying quantities of lint, the seed were delinted by acid before they were cut. The average oil content of the seed is 30.66 per cent., and the variation is from 28.34 to 32.50 per cent., or 4.16 per cent. oil in the kernels. Eight of the samples, out of the 26, contain more than 31 per cent. oil. The average percentage of oil in the seed is 18.1 per cent. The highest is 20.64 and the lowest is 16.58 per cent. The highest oil is associated with the highest percentage of kernels.

TABLE 44.—COMPOSITION OF SEED KERNALS 1915 DELINTED BY ACID.

Lab. No.	Description	Protein	Ether Extract	Water	Per Cent Kernels	Per Cent Oil in Seed
10157	Exp. 729 B165	41.80	30.35	5.37	57.1	17.33
10158	Exp. 729 B164	39.19	32.50	4.72	63.5	20.64
10159	Exp. 729 B 1	42.27	29.75	5.78	60.1	17.88
10160	Exp. 729 B 3	40.56	28.34	6.04	58.5	16.58
10161	Exp. 729 B123	42.88	30.25	5.76	58.7	17.76
10162	Exp. 729 B 78	38.93	31.31	5.38	60.6	18.97
10163	Exp. 729 B217	41.06	31.08	5.23	59.4	18.46
10164	Exp. 729 B206	42.28	30.94	4.75	58.5	18.10
10165	Exp. 729 B 64	41.51	30.63	4.94	58.4	17.89
10166	Exp. 729 B205	40.57	31.40	4.90	60.5	19.10
10167	Exp. 729 B118	41.30	31.21	4.70	58.8	18.35
10168	Exp. 729 B 79	41.62	30.77	5.13	59.4	18.28
10169	Exp. 729 B215	41.74	30.47	4.66	57.9	17.65
10170	Exp. 729 B175	40.18	31.20	5.08	58.5	18.25
10171	Exp. 729 B 77	40.00	30.50	5.57	60.6	18.48
10172	Exp. 729 B135	42.55	29.72	5.58	60.7	18.04
10173	Exp. 729 B211	41.75	30.23	5.10	58.7	17.75
10174	Exp. 729 B126	41.19	30.47	5.13	59.1	18.01
10175	Exp. 729 B149	42.04	32.18	5.43	57.0	18.34
10176	Exp. 729 B124	40.51	30.57	5.83	59.0	18.04
10177	Exp. 729 B201	42.56	30.20	5.48	55.6	16.79
10178	Exp. 729 B214	41.31	30.52	5.46	58.4	17.82
10179	Exp. 729 B129	42.48	30.97	5.64	61.1	18.92
10180	Exp. 729 B171	43.07	30.37	6.16	59.8	18.16
10181	Exp. 729 B130	40.69	31.44	5.90	58.4	18.36
10182	Exp. 729 B183	40.97	29.81	5.82	56.6	16.87
	Average	41.34	30.66	5.36	59.0	18.11

The following selections contain over 18.6 per cent. oil: B 164, B 78, B 205, B 129. The following selections contain less than 17.6 per cent. oil (0.5 per cent. less than the average): B 165, B 3, B 201, B 183. Some of these selections will be planted by the Division of Agronomy to see what character of seed they will produce.

RELATION OF COMPOSITION OF SEED TO COMPOSITION OF MEAL.

While the composition of the seed affects the yield of meal and cake, as manufactured, rather than the composition on a protein basis, there is yet a relation between the composition of the seed and the composition of the meal made from it.

This is reflected in the standards adopted for cottonseed meal already given, which vary somewhat from State to State, being highest of all in Texas.

There is also a relation between the protein and crude fiber content of the meal, and the quality of the seed from which it is made. Thus if two meals of the same protein content are made, one from seed of high protein content, and one from seed of low protein content, the crude fiber content will be higher in the meal made from seed of a high protein content, and lower in the meal made from seed with a lower protein content. By taking the protein and crude fiber into consideration together, one may get an idea as to the quality of the original seed as regard protein. The varying amount of lint present affects the accuracy of the estimate. Of course, it is not possible to form an opinion as to the amount of oil present in the original seed.

Table No. 45 shows the average composition of the kernel residue from a number of seed, based on 14 per cent. fat and water content, and also the average composition of cottonseed hulls on the same basis.

TABLE 45.—AVERAGE COMPOSITION OF COTTONSEED KERNELS ON 15% WATER AND FAT BASIS.

	No. Average.	Protein	Ether extract	Crude Fiber	Nitrogen Free Extract	Water	Ash
Texas Seed, 1913	66	54.32	7.00	3.01	21.43	8.00	6.24
Texas Seed, 1914	59	54.70	7.00	3.10	21.00	8.00	6.20
Texas and Oklahoma Seed Committee	14	54.36	7.00	2.55	22.08	8.00	6.01
Eastern Seed, Committee	32	49.80	7.00	2.79	25.24	8.00	7.20
Cottonseed Hulls, from as named, average	.....	3.30	6.00	42.35	36.91	9.00	2.44

If one pound of cottonseed hulls replaces one pound kernel residue in the residue of the composition given in Table No. 37, we would have from Texas seed, fat and water remaining constant, on an average, 0.033 pounds protein, taking the place of 0.543 pounds of protein, or a decrease of 0.51 pounds protein. We would also have 0.424 pounds crude fiber taking the place of 0.03 pounds crude fiber, or an increase of 0.39 pounds crude fiber. Thus for a decrease of one pound protein we would have an average increase of 0.76 pounds crude fiber.

Proceeding in the same way with the kernel residue from Eastern seed, we find that $\frac{39}{.465} = .84$ pounds crude fiber takes the place of one pound protein.

Thus, the protein content of the original kernel residue could be approximately calculated from the following formula:

$$N = P + \frac{F-3}{L}$$

Where N = protein in seed residue.
P = protein in meal.
F = crude fiber in meal.
L = 0.84 for Eastern seed and .76 for Texas or Oklahoma seed.

If the fat and water content of the meal is far from 15 per cent., it should be calculated to this basis for accurate results. However, on account of the variation of relative proportions of lint and kernel in meal, this is not necessary. For rapid and approximate calculations, we may use the following formula:

$$N = P + (F-3)\ 1.2$$

For a still more rapid and approximate check, the protein and crude fiber may be simply added. This is a useful rough check on analytical work, since the sum of the protein and crude fiber is fairly constant in a given locality.

The fact must be recognized that seed vary in composition. The preceding formula gives a method by which the protein content of the original kernel residue may be estimated from the analysis of the meal.

The same method may also be used in estimating the protein content of the meal that would have a desired crude fiber content.

Thus suppose a meal from Eastern seed contains 36 per cent. protein and 11 per cent. crude fiber. What per cent. of protein would it contain with 9 per cent. crude fiber?

$$N = P + (11-9)\ 1.2$$
$$= 36 + 2.4 = 38.4 \text{ per cent. protein.}$$

A meal contains 42 per cent. protein and 6 per cent. crude fiber. What percentage of crude fiber will it contain with 36 per cent. protein?

$$(42-36)\ .8 = 4.8$$
$$6 + 4.8 = 10.8 \text{ per cent crude fiber.}$$

If the probable maximum crude fiber, and not the average, is to be considered, as is necessary in making a guarantee under feed control laws, the safest plan is to estimate that 1 per cent. crude fiber replaces 1 per cent. protein. Thus the guarantee on the meal containing 42 per cent. protein above cited would be 12 per cent. crude fiber.

ESTIMATION OF LINT ON COTTON SEED.

The writer has seen no published method for the estimation of lint on cotton seed, though he is aware of the fact that methods, involving the use of sulphuric acid, are in use by some commercial chemists.

Preliminary Work.—The preliminary work included a study of the

strength of acid, the time and manner of drying, and the effect of the acid on the hulls themselves, without lint.

The general method used in the preliminary tests is described as follows:

Weigh about 5 grams seed into a dry beaker, add about 10 c.c. concentrated sulphuric acid, and stir continuously with a glass rod until all lint except that on the tip of the seed has dissolved. This will take about one minute. Pour acid and seed on a perforated porcelain plate in a funnel; drain and wash thoroughly, adding a quantity of water at once so as to avoid heating the acid. Wash the seed thoroughly, spread on filter paper, dry in steam oven for thirty minutes and weigh.

Effect of Strength of Acid.—This was tested by adding 10 c.c water to 100 c.c. acid, allowing to cool, and then using it to delint 5 grams cottonseed. The delinted seed were dried in a steam oven for twenty minutes, exposed to the air over night, and weighed.

A similar test was made with 20 c.c. water to 100 c.c. acid.

TABLE 46.—EFFECT OF STRENGTH OF ACID IN AMOUNT OF LINT.

Laboratory Number	Conc. Acid		10 c.c Water to 100 c.c Water		20 c.c Water to 100 c.c. Water	
	Time	Per Cent	Time	Per Cent	Time minutes	Per Cent
9319	1.16	13.5	25	19.1	3	17.6
9320	1.0	12.9	29	15.9	2½	16.6
9321	1.33	7.8	13	9.9	1½	11.1
9322	1.66	12.6	26	15.2	2	16.3
9323	1.0	15.3	30	17.9	2½	17.9
9325	2.0	15.5	30	18.1	3	19.6

The results, compared with concentrated acid, are shown in Table No. 46. The concentrated acid delints the seed much more quickly and gives lower results. Hence its use is preferable.

Method of Drying.—We here studied the differences found by drying thirty minutes, drying four hours, and allowing to remain exposed to the air over night. The results are in Table No. 47.

TABLE 47.—EFFECT OF METHOD OF DRYING SEED ON AMOUNT OF LINT.

Laboratory Number	Gain in standing over Night	Loss in Drying Four Hours
9317	0.85	6.37
9320	0.94	5.76
9321	0.92	5.62
9322	1.05	5.43
9323	0.97	5.23
9325	1.00	5.23

This is a gain of 0.85 to 1.00 per cent. in exposure over night. This consists of water taken up by the seed and is near the original water content.

It would, of course, be possible to base the method upon water-free seed.

Solution of Hull-Bran.—It is obvious that the solvent action of the sulphuric acid upon the hull-bran is an error in this method.

In order to ascertain the possible magnitude of this error, several experiments were made. In one series of experiments the seed already delinted by acid were subjected to a further treatment with acid, for two minutes in one case, and for four minutes in another. The seed were then dried thirty minutes and then exposed to the air over night. In another experiment, seed carrying little lint were selected, and the lint present was removed, with the exception of a small amount at the tip. The seed were then treated for one minute with concentrated sulphuric acid, dried thirty minutes, and exposed to the air over night. The results are given in Table No. 48.

TABLE 48.—HULL DISSOLVED BY ACID.

Laboratory Number	Delinted by Acid		Delinted by Hand
	4 Min.	2 Min.	1 Min.
9319	3.86	2.68	.....
9320	3.05	2.10	.....
9321	3.34	3.00	.....
9322	3.58	2.29	.....
9323	3.36	2.36	.....
9325	3.34	3.60	.....
9383	.....	.....	2.2
9787	.....	.....	2.3
9717	.....	.....	2.4
9454	.....	.....	2.4
9458	.....	.....	2.5
9321	.....	.....	2.4

The results show that about 2.5 per cent. hull are dissolved by the acid in one minute. A larger quantity is dissolved during a longer period. We suggest a correction of 2.5 per cent.

METHOD PROPOSED.

The method finally proposed by us is described as follows:

Weigh nearly 10 grams whole cotton seed, record exact weight, place in a dry beaker, add about 15 c.c. of concentrated sulphuric acid, and stir continuously and thoroughly with a glass rod until all of the lint, with the exception of a very little on the tip of the grain, has dissolved. This will take about one minute. Note the time taken. Pour the acid with seed on a perforated plate or porcelain crucible top in a funnel so that the acid will run off quickly. Wash quickly with a quantity of tap water; next, spread on ordinary paper and dry for thirty minutes in the steam oven; then allow to remain exposed to the air over night but protected from mice. Weigh and calculate per cent. and report percentage of "Dissolved lint," giving also time of contact.

Care must be taken to select average seed, which are not broken and which carry no trash; and to allow contact between acid and seed as long as needed.

QUANTITY OF LINT FOUND.

Percentages of dissolved lint on different varieties of seed ginned with a small gin are given in Tables Nos. 38, 39, and 40. The percentages vary more when averaged by variety (Table No. 41) than by locality (Table No. 39). By locality, the averages varied from 11.5 to 13.7 per cent.; by variety from 7.1 to 14.9 per cent. These averages are not corrected by allowing for the amount of hull dissolved, which is about 2.5 per cent. If this correction should be made, the seed would carry 9 to 11.5 per cent. lint, averaged by locality, or 180 to 230 pounds per ton.

TABLE 49.—PERCENTAGE OF DISSOLVED LINT ON SEED, U. S. D. A.

Laboratory Number	U. S. D. A. No.	Per Cent Lint
9413	27401H	7.2
9414	27403	6.0
9415	27405	8.6
9416	27407	6.5
9417	27409	10.2
9418	27411	8.5
9419	27413	7.8
9420	27415	6.3
9421	27417	7.0
9422	27419	10.5
9423	27421	8.3
9424	27423	6.2
9425	27425	7.1

Table No. 49 shows the percentage of lint on some of the seed collected by Mr. Bidwell of the U. S. Department of Agriculture, analyses of which are given in Table No. 23. These seed had been reginned and were ready to have the hulls removed. They carry, after a deduction of 2.5 per cent. for dissolved hull, from 3.7 to 7.7 per cent. lint, with an average of 5.4 per cent., or from 74 to 154 pounds, with an average of 112 pounds per ton. At the time these seed were collected, the oil mills were not ginning as closely as they have been doing in 1915-16, and the reginned seed would now carry much smaller percentages of lint.

DIRT WITH COTTON SEED.

During the process of ginning, the dirt and trash are removed separately, but in a number of cases they are mixed with the ginned seed by the ginner. This practice has been prohibited by the Warehouse Law of Texas, passed in 1915. The practice is, however, still followed in other States. The dirt and trash must, of course, be removed before the cotton seed can be passed through the oil mill machinery. The addition of trash or dirt which has been removed during the process of ginning merely involves extra work on the part of the oil mill. It increases the operating cost and decreases the output per ton of seed. This is usually distributed over the entire amount of seed purchased and decreases the price paid for the seed; so that there is no gain to the farmer due to this addition of dirt and trash, but there is really a loss, due to the additional cost of its removal. The

practice of adding dirt and trash should be prohibited by the laws of all States, as has been done in Texas.

ACKNOWLEDGMENT.

Analytical and other work involved in this bulletin has been done by Messrs. Asbury, Rather, Ogier, Hodges, Hudgins, Sprott, Weaver, Roark, Buchwald, Enochs, and others.

SUMMARY AND CONCLUSIONS.

1. Cottonseed meal on the Texas market has, on an average, decreased in feeding value until it has reached the minimum permitted by the Feed Control Service.

2. Cottonseed meal has also decreased in feeding value in other States.

3. The decrease is due to changes in the method of milling and to regulation of the hull content for the purpose of making meal of the desired protein, or protein and fat content.

4. A description of the process of oil milling is given.

5. Chemical control of oil milling has increased the efficiency of oil extraction.

6. It is possible to secure a low oil content of the cake when the crude fiber is 7 to 9 per cent., though, under ordinary conditions, 9 to 11 per cent. appears to lead to a better extraction.

7. Tables are given showing the relation of crude fiber content to the production coefficients of cottonseed meal.

8. Standards for cottonseed meal are 7 per cent. ammonia (equivalent to 36 per cent. protein) in South Carolina, 7.5 per cent. ammonia (equivalent to 38.62 per cent. protein) in North Carolina, Georgia, and Alabama, 38 per cent. protein and not over 11 per cent. crude fiber in Oklahoma, and 51 per cent. protein and fat and not over 11 per cent. crude fiber in Texas.

9. Definitions of cottonseed meal are given.

10. Cottonseed meal may be regulated by its protein content, or protein and crude fiber content.

11. Methods for estimating hulls in cottonseed meal are discussed.

12. Methods for calculating yield of oil and meal from the composition of the seed are discussed.

13. Composition of cotton seed is affected by maturity of seed, locality, variety, and weather conditions.

14. The same variety grown in different localities has a different composition.

15. Different varieties grown in the same locality have a different composition.

16. Oil millers can afford to pay more for seed yielding larger quantities of oil.

17. The composition of the seed is related to the composition of the meal made from it. A method of calculating the original protein content of the seed residue is given.

18. A method for estimating lint on cotton seed is given.